A Prospective Study of

Functional outcome of Hemiarthroplasty for proximal humeral fractures - Short term prospective outcome analysis

Dissertation submitted to

THE TAMILNADU Dr. M.G.R. MEDICAL UNIVERSITY

Chennai

In partial fulfillment of the regulations

for the award of the degree of

MS (ORTHOPAEDIC SURGERY)

BRANCH – II

MADRAS MEDICAL COLLEGE

CHENNAI

MARCH - 2013

CERTIFICATE

This is to certify that this dissertation in **" Functional outcome of Hemiarthroplasty for proximal humeral fractures - Short term prospective outcome analysis"** is a bonafide work done by **Dr. NIRANJANAN.M.RAGHAVN** under my guidance during the period 2010 – 2013. This has been submitted in partial fulfillment of the award of **M.S.** Degree in **Orthopedic Surgery (Branch – II)** by the Tamilnadu Dr. M.G.R. Medical University, Chennai.

Prof M .R .RAJASEKAR
DIRECTOR,
INSTITUTE OF ORTHOPAEDICS & TRUAMATOLOGY
MADRAS MEDICAL COLLEGE&
RAJIV GANDHI GOVT GEN. HOSPITAL
CHENNAI – 3.

Prof. A.PANDIASELVAN
PROFESSOR,
INSTITUTE OF ORTHOPAEDICS & TRUAMATOLOGY
MADRAS MEDICAL COLLEGE&
RAJIV GANDHI GOVT GEN. HOSPITAL
CHENNAI – 3.

Prof. V. KANAGASABAI, M.D.,
DEAN
MADRAS MEDICAL COLLEGE &
RAJIV GANDHI GOVT GEN. HOSPITAL
CHENNAI – 3.

DECLARATION

I, **Dr. NIRANJANAN.M.RAGHAVN,** solemnly declare that the dissertation titled **"Functional outcome of Hemiarthroplasty for proximal humeral fractures - Short term prospective outcome analysis"** was done by me at The Rahiv Gandhi Government General Hospital, Chennai – 3, during 2010-2013 under the guidance of my unit chief **Prof. A.PANDIASELVAN, M.S(Ortho), D. Ortho.**

The dissertation is submitted in partial fulfillment of requirement for the award of M.S. Degree (Branch – II) in Orthopaedic Surgery to **The Tamil Nadu Dr. M.G.R. Medical University.**

Place:

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(Dr. NIRANJANAN.M.RAGHAVN)

Date:

Signature of the Guide
Prof. A.PANDIASELVAN M.S(orth) D.orth
PROFESSOR,
INSTITUTE OF ORTHOPAEDICS & TRUAMATOLOGY
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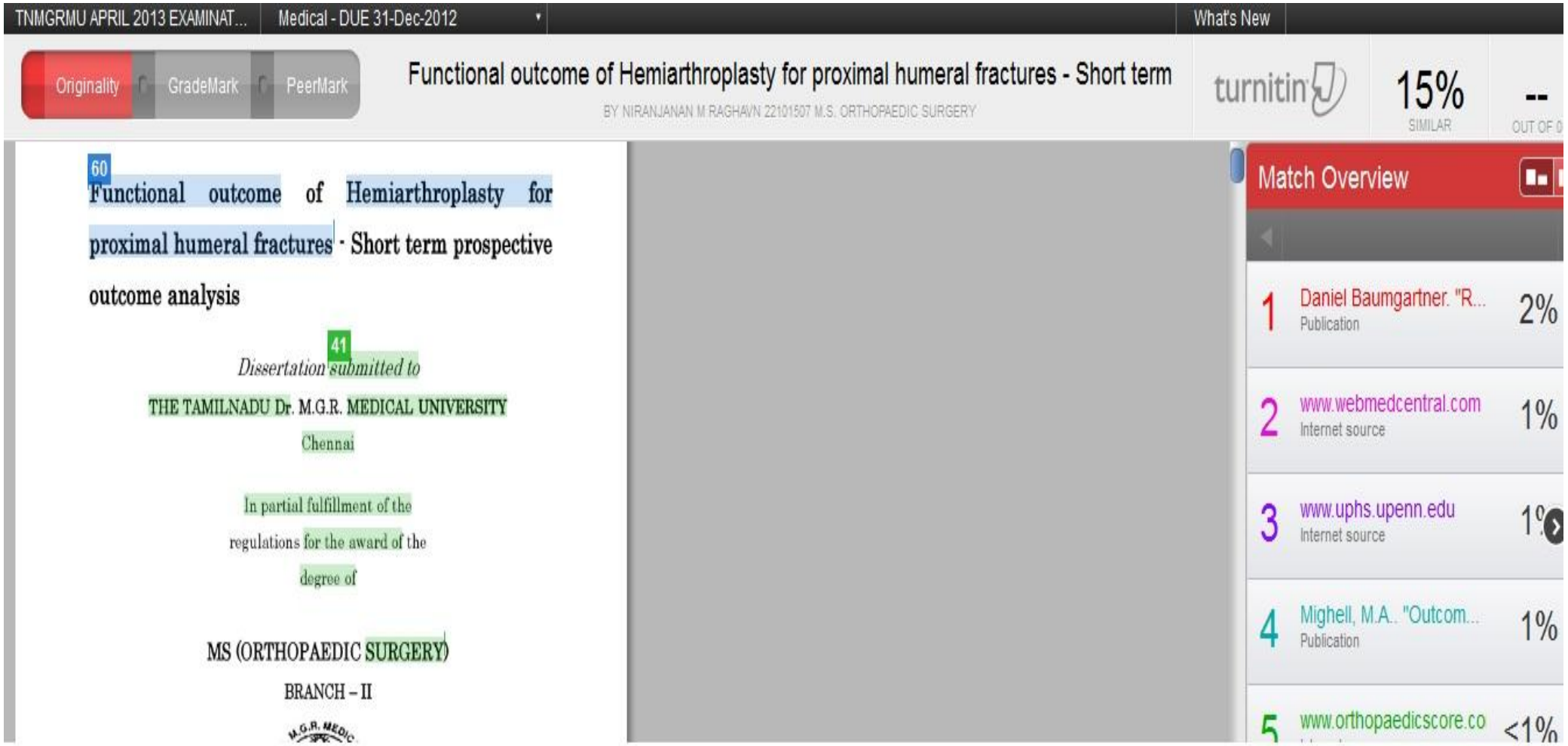
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To
Dr. Niranjanan M. Raghavan
PG in MS Orthopaedics
Madras Medical College, Chennai -3

Dear Dr. Niranjanan M. Raghavan

The Institutional Ethics committee of Madras Medical College, reviewed and discussed your application for approval of the proposal entitled "A study on functional outcome of Hemiarthroplasty for proximal humeral fractures " No.14092012.

The following members of Ethics Committee were present in the meeting held on 13.09.2012 conducted at Madras Medical College, Chennai -3.

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We approve the proposal to be conducted in its presented form.

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The Institutional Ethics Committee expects to be informed about the progress of the study, and SAE occurring in the course of the study, any changes in the protocol and patients information / informed consent and asks to be provided a copy of the final report.

Member Secretary, Ethics Committee

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CONTENTS

Introduction

INTRODUCTION

Proximal humeral fractures constitute 45% of all humeral fractures and up to 5% of the total fracture incidence [1]. The incidence of proximal humerus fractures rise to nearly 76% above the age of 45 years [1]. It is the third commonest cause of fractures after hip and distal radius fractures in people above 65 years of age [2].

More than 85% of these fractures are only minimally displaced [3].Such fractures may be treated conservatively [1].

A low or moderate energy fall in an old person whose bone quality is poor is the commonest mode of developing a proximal humeral fracture [4].

Displaced fractures of the proximal humerus continue to pose challenges to the orthopaedic surgeon. Poor bone quality, weak surrounding soft tissues, associated co-morbidities complicate the management of these injuries [5].

Prosthetic Hemi-arthroplasty is the standard of care for markedly displaced fractures, including 4 part fractures, fracture dislocations, head splitting fractures, fractures with impression defects involving more than 45% of the humeral head[6] [7] [8] [9] [10]. Some patients with 3 part fractures may also need to be considered for hemiarthroplasty because of advancing age, severe comminution and poor bone stock.

Non operative management is associated with uniformly poor outcomes [9] [11]. Primary hemiarthroplasty of these fractures is associated with satisfactory pain relief. However functional results have not been uniform [12] [13] [14] [15]. Primary hemiarthroplasty is preferable because revision or prosthetic replacement as a salvage procedure causing numerous complications leading to poor functional outcome [12] [13] [14] [15].

Common complications of prosthetic replacement include infection, intraoperative fracture, instability, tuberosity malposition and stiffness [15]

This study is undertaken to analyse the short term functional outcome of hemiarthroplasty of proximal humeral fractures in Indian patients.

Aim

AIM OF THE STUDY

To analyse the short term functional outcome of 3 part and 4 part proximal humerus fractures treated with hemiarthroplasty at the Institute of Orthopaedics and Traumatology, Madras Medical College and Rajiv Gandhi Government General Hospital, Chennai between May 2010 and December 2012

Historical Review

HISTORICAL REVIEW

460 BC	Hippocrates first described proximal humerus fractures. He also described traction for treatment
1896	Kocher developed an anatomic classification – not simple enough, lacked consistency
1893	Pean described the first prosthetic replacement of the shoulder- a platinum and rubber prosthesis for glenohumeral tb[60]
Early 20th century	Closed reduction and traction abduction splints were used but results not encouraging
1934	Codman proposed his classification system in which he sub- divided the proximal humerus into distinct 4 parts. This was the basis of Neer's classification[20]
1951	Original Neer I prosthesis is designed
1955	Neer published his series of 27 cases in which metal humeral head prosthesis was used [62]
1970	Neer's classification system proposed[61]
early 1970's	AO-ASIF used plates and screws
1972	Total shoulder prosthesis of Stanmore and Bichel designed [63]
1973	Neer II prosthesis developed
1985	Reverse shoulder prosthesis developed
1994	Delta III prosthesis developed
2000s	Introduction of PHILOS plate

Anatomy

ANATOMY

Developmental Anatomy [45], [46], [47]:

The proximal humerus develops from 3 primary centres for ossification – one for the head, one for the greater and one for the lesser tuberosities. The first to appear, at around 8th week of intra-uterine life is the centre for the body which provides most of the initial development. The centre for the head is the next to develop at around 3rd month of life. The centres for the greater and lesser tuberosity develop at the 3rd and 5th year of life respectively. The 3 fuse together by the 6th year of age so as to produce a single epiphysis. Ossification is usually complete by 20 years. In contrast to the proximal femur, the humerus retains its spherical shape throughout development.

Gross Anatomy [46], [47], [50], [51]:

Humerus is the bone of the upper arm in the body and the largest bone of the upper limb. Humerus is derived from the Latin word "umerus" meaning "upper arm" [48].

Humerus consists of a tubular shaft and upper and lower ends. The upper end is expanded when compared to the shaft and consists of a head, a greater tuberosity and a lesser tuberosity. The head and the glenoid articulate to form the shoulder joint. The region where the head joins the shaft is the surgical neck.

Head:

The proximal end of the humerus is the head, which articulates with the glenoid to form the shoulder which is a type of ball and socket joint, the head of the humerus being likened to the ball. In anatomical position the head is directed upwards backwards and medially. It is covered by hyaline cartilage.

Greater tuberosity:

A projection on the lateral to the head is the greater tuberosity which is an important determinant of the contour of the shoulder. It projects beyond the acromion. It provides attachment to 3 of the 4 rotator cuff muscles namely the supraspinatus, the infraspinatus and the teres minor. It is covered by the deltoid muscle.

Lesser tuberosity

Lesser tuberosity is an anterior projection lying beyond the anatomical neck. Subscapularis muscle and the transverse ligament of the shoulder are attached to it.

Anatomical Neck

Anatomical neck is the constriction that is present below the head of the humerus. It is better defined antero-inferiorly and postero-inferiorly and ill

defined superolaterally because of the presence of inter-tubercular sulcus. Anatomical neck is the level of capsular attachment.

Intertubercular Sulcus

It is also known as intertubercular groove and it lies between the greater tuberosity and the lesser tuberosity. It forms a key landmark in replacement because the tendon of the long head of the biceps, considered the lighthouse of the proximal humerus passes through it. Its anterior lip gives attachment to pectoralis major, posterior lip to teres major and the groove the lattissimus dorsi.

Glenoid

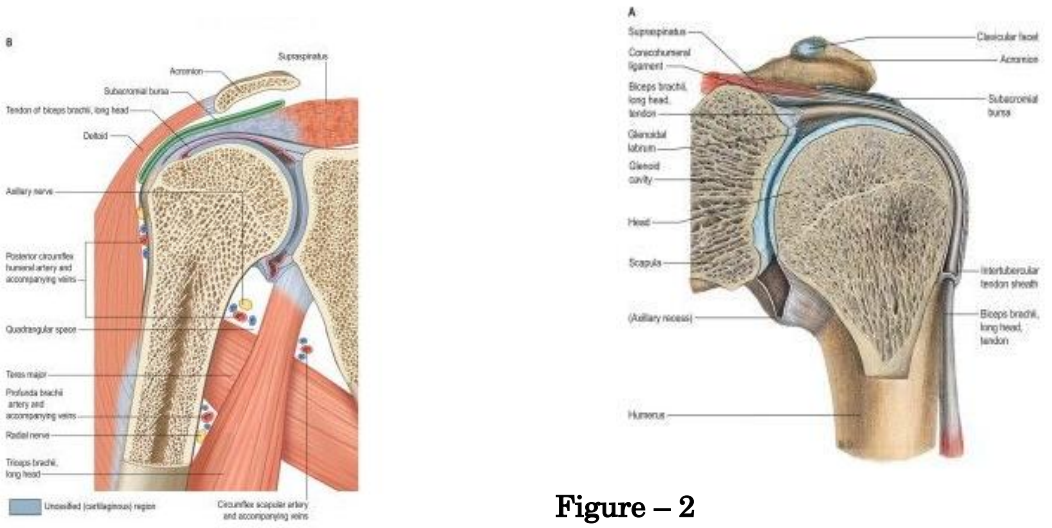
Glenoid forms the socket of the glenohumeral joint. It is an inverted comma shaped structure and is the lateral part of the body of the scapula.

Figure – 1

A, Anterior aspect of proximal end of left humerus. B, Posterior aspect of proximal end of left humerus. **A: 1**. Head. **2**. Anatomical neck. **3**. Surgical neck. **4**. Greater tubercle. **5**. Lesser tubercle. **6**. Intertubercular sulcus. **7**. Shaft. **B: 1**. Greater tubercle. **2**. Surgical neck. **3**. Shaft. **4**. Radial groove. **5**. Head. **6**. Anatomical neck.

Glenohumeral joint:

It is a polyaxial synovial joint between the humeral head and the glenoid process. It is a joint with maximum mobility and minimum stability. Since the glenoid covers approximately 1/3rd of the humeral head (cf. acetabulum) it is inherently unstable. The glenoid labrum which is attached to the periphery of the glenoid adds to the depth and stability. The stability is an interplay between various muscular and bony components. The hyaline cartilage is thicker in the centre and thinner in the periphery in the head and vice-versa in the glenoid. Maximum congruence between the 2 articulating surfaces is reached when the humerus is abducted and laterally rotated.



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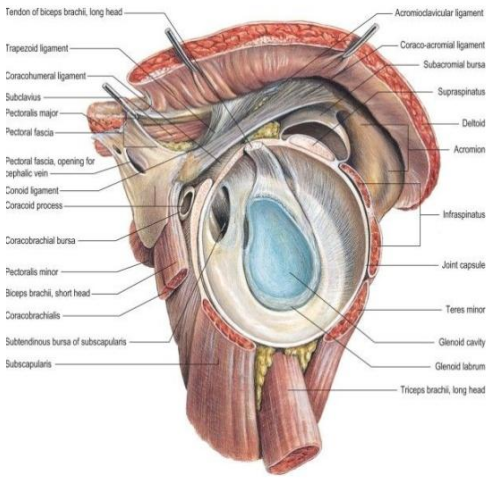


Stabilizers of the joint

The joint is stabilized both by static and dynamic stabilizers.

The various Static stabilizers are

1. Fibrous capsule

2. Ligaments

    - Glenohumeral, coracohumeral and transverse humeral ligament

3. Glenoid labrum

Dynamic stabilizers:

The dynamic stabilizers consists of the rotator cuff muscles and the muscles surrounding the joint namely deltoid, serratus anterior, trapezius and lattissimus dorsi.

Factors influencing dynamic stability [50] include the retroversion of the humeral head, the retro tilt of the glenoid process and the balance between the various muscular forces acting across the joint. The rotator cuff consists of the supraspinatus the infraspinatus, the teres minor and the subscapularis.

Vascular Supply [46], [52], [53], [54], [55]

The blood supply to the proximal humerus assumes significance due to the fact that some fracture patterns predispose the humeral head to avascular necrosis. The fracture may also lead to a vascular injury.

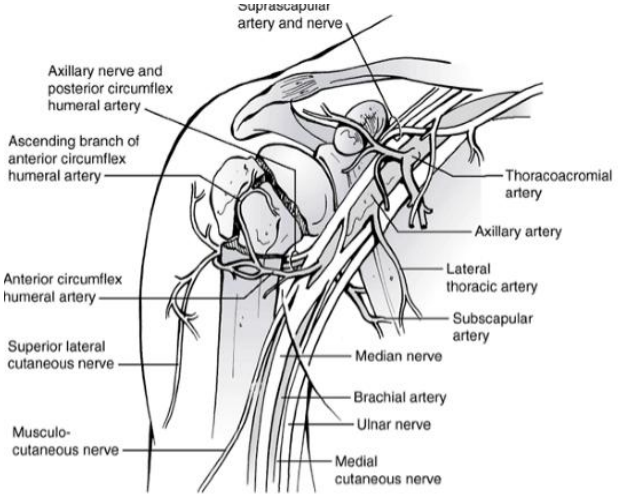


Figure no- 4 [53]

The 3rd part of the axillary artery serves as origin to the anterior circumflex humeral branch at the inferior border of the subscapularis. The anterior circumflex humeral artery winds around the shaft to anastamose with the posterior circumflex artery, which also arises from the 3rd part of the axillary artery.

The anterior circumflex humeral artery cross the bicipital groove on its lateral aspect and continues to become the arcuate artery of Liang at the articular surface. Fracture at the level of the anatomical neck disrupting this artery causes avascular necrosis of the humeral head and fractures that are significantly displaced may also cause axillary artery injury.

Nerve Supply

The shoulder joint has a rich nerve supply from the axillary, musculocutaneous and suprascapular nerves.

Biomechanics

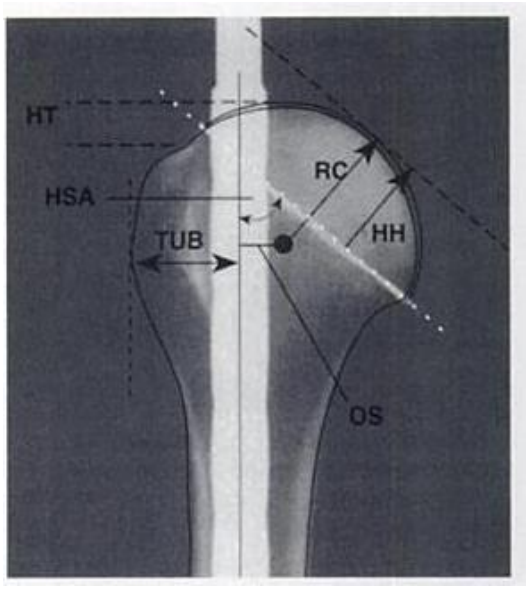
BIOMECHANICS

Shoulder joint Biomechanics:

Retroversion: The retroversion of the humerus has been found to vary extremely in the general population. The retroversion of the right and left sides in the same person may also vary [30], [31], and [32].The retroversion ranges between 0-55^{o} with a mean of 17.9 ^{o}. The retroversion depends on the referencing axis used. Two types of referencing are used, proximal and distal. Proximal referencing used include a plane passing through the articular surface, a line joining the central point of the articular surface and the centre of rotation of the humeral head or a line drawn from the central point of the articular surface to the greater tuberosity. Distal referencing includes the trochlear axis, trans-epicondylar axis or the forearm itself. We have used the trans-epicondylar axis as the reference in our study.

Head Shaft angle: The angle between the articular surface and the long axis of the shaft is the Head shaft angle and it varies from 30^{o}-55^{o} [31].

Radius of curvature and Head height: The head is spherical at the centre although radius of curvature is lesser in the sagittal plane compared to the coronal plane. The ratio of the radius of curvature to head height is 4:3[31]



RC – Radius of curvature

HAS – Head shaft angle

HT – Height of Tuberosity

HH – Height of the humeral head

OS - Offset

Figure – 5

Tuberosity Height: It is defined as the height of the humeral head relative to that of the greater tuberosity. Usually the head lies at about 8 mm (+/- 3mm) over and above the greater tuberosity [36]

Offset: Offset is the distance between the centre of the proximal humeral articular surface and the centre of the medullary canal. In the transverse plane this is known as the antero-posterior offset whereas in the coronal plane it is called the medial offset. Posterior offset ranges from 4-14 mm and medial offset from -2 to 10 mm [30] [31] [33] [34].

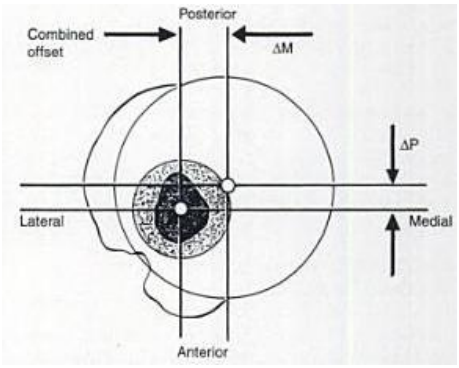


Figure – 6

Fracture Biomechanics

Most proximal humeral fractures are due to indirect injury, the most common being fall on an outstretched hand [25], [26], and [27]. A combination of factors are at play including relatively osteoporotic bone in the elderly, contact against adjacent glenoid and acromion, pull of intrinsic muscles (rotator cuff) and extrinsic muscles (pectoralis major [26],[27],[28]. The fracture configuration is dependent on the density of bone in the proximal humerus and the position of the arm while striking the floor.

The fracture displacement depends on the action of these muscles

1. The pectoralis major tends to pull the humeral shaft anteriorly and medially
2. The supraspinatus and infraspinatus tend to pull the greater tuberosity posterosuperiorly
3. The subscapularis tends to pull the lesser tuberosity medially
4. The articular fragment does not have any muscle attachments.

Hence these fragments must be reduced accurately and attached so as to prevent redisplacement.

Prosthesis Biomechanics

Prosthesis is based on Neer's prosthesis design and modular hemi arthroplasty prosthesis.

Modular prosthesis:

The stem is available in 5, 6, 7 sizes. Modular head sizes are available from 31 – 45 sizes.

Length of the prosthesis – 16 cm

Head shaft angle – 135^0

Diameter at the neck 2.4 cm

Fin is present to attach the tuberosities to the prosthesis

Neer's unipolar prosthesis:

Stem is either 6, 7 sizes. Head sizes are 31- 41

Length of the prosthesis – 17 cm

Head shaft angle – 130^0

Diameter at the neck 2.2 cm

Fin is present to attach the tuberosities to the prosthesis

Classification

CLASSIFICATION

Various classification systems have been proposed for classifying proximal humeral fractures.

Kocher's classification [19]:

Proposed in 1896, this classification is based on the anatomic location of the fracture

i. anatomic neck

ii. metaphysis

iii. surgical neck

Advantages:

Simple to understand and use

Disadvantages:

1. Does not account for multiple fractures lines and complex fracture patterns

2. No distinction is made between displaced and undisplaced fractures

Codman's classification [20]:

Proposed in 1934, he pioneered the classification of proximal humerus fractures into 4 parts namely

1. Head
2. Greater Tuberosity
3. Lesser tuberosity
4. Shaft

This classification was based on the epiphyseal scar which is a remnant of the old epiphyseal plate.

Neer's classification [21] [22] [8]:

In 1970 Neer proposed his classification that incorporated displacement and vascular isolation of the fracture fragments into the classification and related it to the diagnosis and treatment.

Undisplaced: According to his classification the fracture is considered undisplaced if the x ray reveals less than 1cm of displacement and 45 degrees of angulation with respect to all other fragments even if more than one fracture line is present.

2 part fracture: Two part fractures involve either the anatomical neck, the surgical neck, the greater Tuberosity or the lesser Tuberosity and if fragment is displaced 1cm or 45 angulated degrees with respect to the other fragments.

3 part fracture: 3 part fractures happen when a displaced fracture of the surgical neck occurs with either a displaced greater Tuberosity or a displaced lesser Tuberosity fracture.

4 part fracture: Four part fractures are displaced fractures of both Tuberosities with a displaced fracture of the surgical neck

Any fracture pattern may be associated with a humeral head dislocation.

Special fractures such as the fractures causing indentation of the head and head spitting fractures are not covered by this classification system

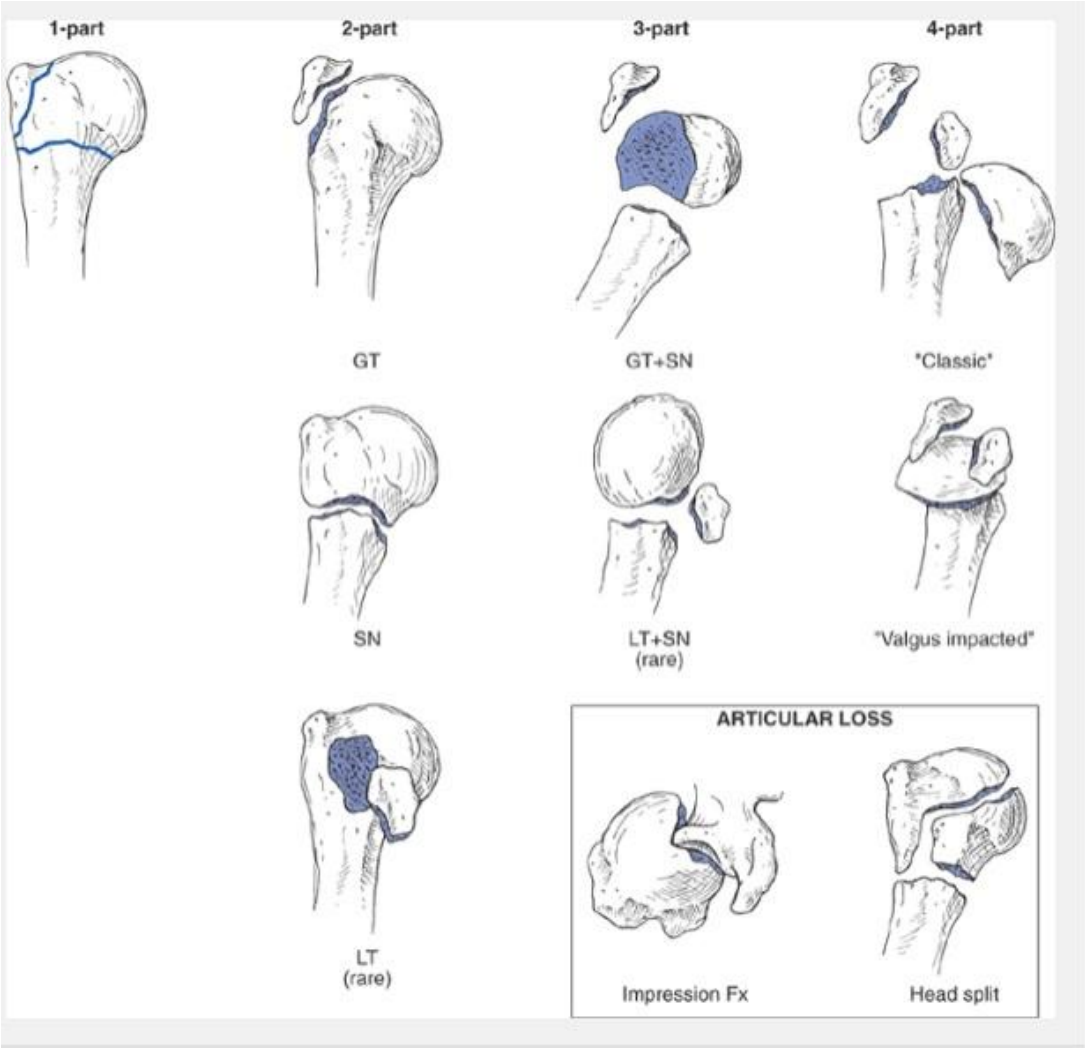

1-part
2-part
3-part
4-part
GT
GT+SN
"Classic"
SN
LT+SN
(rare)
"Valgus impacted"
LT
(rare)
ARTICULAR LOSS
Impression Fx
Head split

Figure – 7

AO-ASIF classification [37]:

A: Extra-articular unifocal fracture

A1 Extra-articular unifocal tuberosity fracture

.1 Greater Tuberosity, not displaced

.2 Greater Tuberosity, displaced

.3 associated with GH dislocation

A2 Extra-articular unifocal impacted metaphyseal fracture

.1 no frontal displacement

.2 varus malalignment

.3 valgus malalignment

A3 Extra-articular unifocal non-impacted metaphyseal fracture

.1 simple, angulated

.2 simple, translated

.3 multi- fragmentary

B: Extra-articular bifocal fracture

B1 Extra-articular bifocal fracture with metaphyseal impaction

.1 Lateral and Gr tuberosity

.2 medial and lesser tuberosity

.3posterior and Gr tuberosity

B2 Extra-articular bifocal fracture without metaphyseal impaction

.1 without rotational displacement

.2 with rotational displacement

.3 multifrag metaphyseal with one of the tuberosities involve

B3 Extra-articular bifocal fracture with GH dislocation

.1 Vertical cervical line, Greater Tuberosity intact, Ant-med dislocation

.2 Vertical cervical line, Greater Tuberosity fracture, Ant-med dislocation

.3 Lesser tuberosity fracture, posterior dislocation

C: Articular fracture

C1 Slightly displaced

.1 cephalotubercular, valgus alignment

.2 cephalotubercular, varus alignment

.3 anatomical neck

C2 Impacted and significantly displaced

.1 cephalotubercular, valgus alignment

.2 cephalotubercular, varus alignment

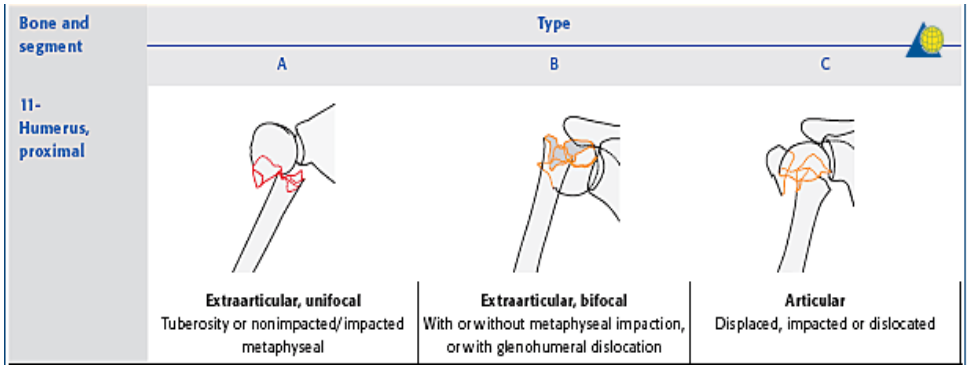
.3 Transcephalic and tubercular, varus alignment

C3 Dislocated

.1 anatomical neck

.2 anatomical neck and tuberosities

.3 cephalotubercular fragments



Avascular Necrosis of Humeral Head:

Cruess X-ray Classification [44]

Class	Description
I	before changes (can be seen on MRI)
II	sclerosis in superior central portion of the head
III	crescent sign - caused by subchondral bone collapse; may have mild flattening
IV	Significant collapse of humeral articular surface.
V	Degenerative joint disease.

Clinico-Radiological Evaluation

CLINICO-RADIOLOGICAL EVALUATION

History

A detailed history should be taken from each patient. Various aspects include age, socio-economic status, occupation, hand dominance. Age, occupation and socio-economic status are factors that are critical in determining the type of treatments that are offered for patients.

Details regarding the mode of injury should be taken with care. Associated co-morbidities like diabetes mellitus, hypertension, tuberculosis, asthma, rheumatoid arthritis are important modifiers of treatment and outcomes.

Clinical Presentation

Fractures of the proximal humerus either tend to present acutely or after a period of conservative treatment from native practitioners.

If acute, patients presenting with pain, swelling and inability to use the affected limb. On examination there is pain swelling tenderness crepitus and abnormal mobility.

A detailed neurovascular examination is mandatory. The nerves to be tested include median nerve, axillary nerve, musculo-cutaneous nerve, redial nerve.

The most common nerve affected in proximal humeral fractures

is the axillary nerve. Sensations are checked in the insertion of the deltoid muscle. Motor component is checked by abduction against resistance and contour of the deltoid muscle.

Radiological evaluation:

X-Rays:

Routine views include antero-posterior and lateral views of the affected shoulder.

Antero-Posterior view [8]:

Since the plane of the shoulder joint is at an inclination of 35^0 to the sagittal plane, to obtain a true antero-posterior view, the beam must be projected at a 35^0 angle to the sagittal plane. This view is also known as AP view in the scapular plane or Grashey's projection. The true AP view shows the joint in profile and tuberosities are outlined.

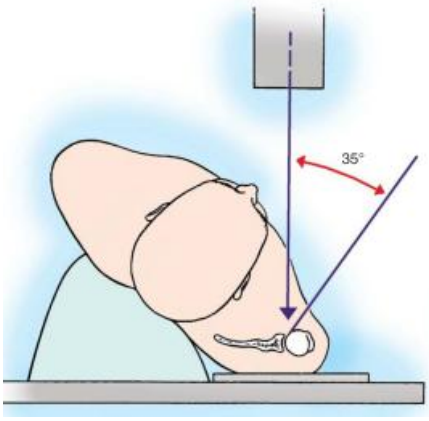


Figure – 9

Lateral Views [8]:

The lateral view of the shoulder in the scapular plane should be

taken by rotating the patient outward by 45^0. The plate is to be placed along shoulder anteriorly and tube parallel to the scapular spine. It is also called the Y-lateral view which shows head centred on the glenoid.

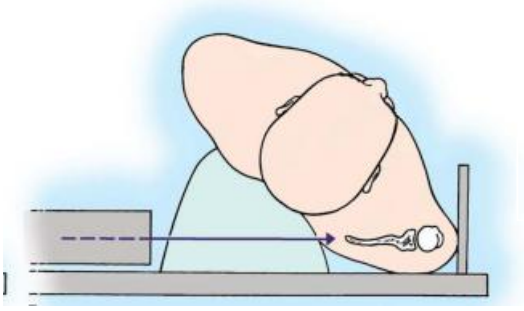


Figure – 10

Axillary view of the shoulder [23]:

This is also known as the Lawrence projection. The patient lies in supine position on the X-ray table with the affected shoulder placed in 90^0 of abduction. The film cassette is placed against the superior aspect of the shoulder with the medial end against the neck, which places the mid-portion of the cassette level with the surgical neck of the humerus. The radiographic tube is kept at the level of the ipsilateral hip and is angled medially toward the axilla.

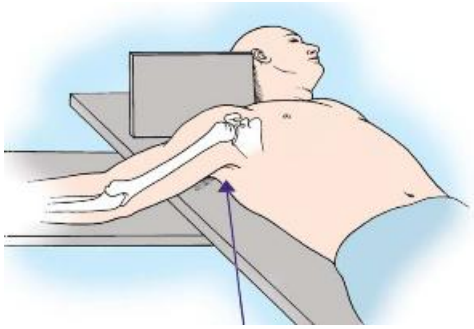


Figure – 11

Velpeau Axillary view of the shoulder [24]:

It was first suggested by Bloom and Obata. It is named Velpeau s view because it is intended to be taken with the patient in a velpeau sling or bandage.

The patient sits or stands with the arm in a velpeau s bandage and leans backwards by 20-30^0 over the table. The placement of the x-ray plate is directly under the affected shoulder and the tube directly above it.

Figure – 12

COMPUTED TOMOGRAPHY:

The investigation of choice for complex fracture patterns of the proximal humerus is CT scan.

It is used to delineate the following details:

1. The relationship between the head and the articulating surface of the glenoid fossa – for the identification of a fracture dislocation
2. To identify the number of fragments and their relationship
3. Head splitting fractures
4. Impression fractures

Newer advancement is the 3 Dimensional reconstruction CT which is valuable in reconstructing complex fracture patterns

Materials and Methods

MATERIALS AND METHODS

This study was designed to determine the short term functional outcome of fractures of the proximal humerus treated with Hemiarthroplasty. From May 2010 to December 2012, 20 patients with 3 and 4 part proximal humerus fractures presenting to the Institute of Orthopaedics and Traumatology, Madras Medical College and Rajiv Gandhi Govt Gen Hospital were treated with hemiarthroplasty. The patient selection criteria are as follows:

Inclusion criteria:

1. Age more than 45 years
2. Neer's classification 3 part and 4 part fractures
3. Closed fractures
4. Fracture dislocation

Exclusion criteria:

1. Age less than 45 years
2. Compound fractures
3. Associated Humeral shaft fractures
4. Associated glenoid fractures

5. Uncooperative patient for post operative rehabilitation

Patients of both sexes satisfying the above inclusion criteria and willing to be enrolled in the study after obtaining informed written consent were included in the study.

PATIENT EVALUATION:

Patients presenting in the outpatient department and emergency department were admitted for further detailed evaluation. Detailed history taking is done to ascertain the duration of injury, mode of injury, co morbid illness, and history of previous surgeries and for ruling out head injury or other system involvement.

Detailed clinical examination is done to assess not only the affected shoulder but also the patient as a whole including a thorough general examination, cardio vascular, respiratory and neurological examination. Complete skeletal survey to rule out other injuries also done.

The affected shoulder is examined thoroughly starting with the skin, to rule out any abrasion or lacerations. A fracture is suspected by the presence of swelling, tenderness, crepitus, and abnormal mobility. Vascular examination of the limb is done by palpating the brachial, radial and ulnar pulses. Neurological examination is done by checking for axillary nerve, musculocutaneous nerve, radial, median and ulnar nerves. All patients fulfilling

the inclusion criteria are then subjected to radiological examination.

RADIOLOGICAL EVALUATION:

Antero-Posterior and lateral views of the affected shoulder, described in the previous section on radiology are initially taken. This was followed by velpeau's view if needed. Then 3-D reconstruction CT scan of the affected shoulder was done.

CLASSIFICATION:

X-rays and CT are used to classify the fractures. Neer's classification **has** been used for our study. Only fractures classified as 3 part or 4 part under Neer's classification have been included in the study.

PRE OPERATIVE WORK UP:

All patients fulfilling the above criteria were initially placed in a 'U' slab. They were subsequently sent for anaesthetic assessment regarding fitness for the procedure. Once the fitness was obtained they were subject to the following surgical procedure.

SURGICAL PROCEDURE:

All 20 patients were operated upon at the Institute of Orthopaedics and Traumatology, Madras Medical College & Rajiv Gandhi Govt Gen Hospital, Chennai.

ANAESTHESIA:

All patients were intubated with endotracheal tube and placed under General Anaesthesia.

PATIENT POSITIONING:

On the operating table, the patient lies supine (modified beach chair) position over a sandbag placed in the interscapular region elevating it by $30\text{-}45^{0}$ [38],[39] The arm is free to hang by the side of the table. It is draped free in order to enable it to be adducted and rotated.

· INCISION [40]:

Start the incision from the coracoid process along the delto pectoral groove for a distance for about 10 – 15 cm.

Figure – 13

SUPERFICIAL DISSECTION:

Subcutaneous tissue opened in layers. The internervous plane lies between the deltoid and pectoralis major. Deltoid is innervated by the axillary nerve and pectoralis major, by the medial and lateral pectoral nerves. Retraction of the deltoid laterally and pectoralis major medially.

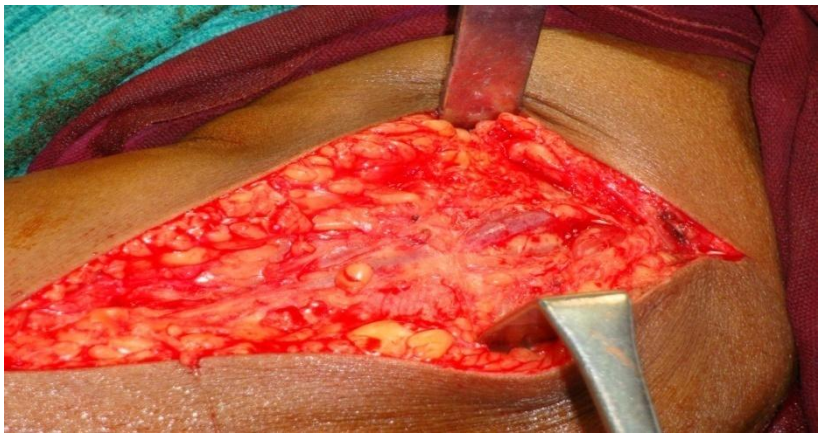


Figure – 14

Cephalic Vein is identified. The vein may be retracted medially or laterally.

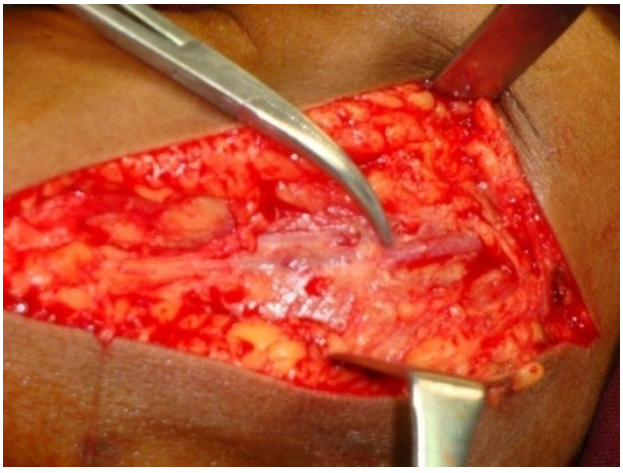


Figure – 15

DEEP DISSECTION [41]:

Clavipectoral fascia which arises over the coraco- acromial ligament is incised, and the underlying acromial branch of the thoraco-acromial artery is identified and coagulated. The anterior circumflex vessels lie in the middle of the wound, just superior to the pectoralis major muscle they are isolated, clamped, and coagulated.

Figure – 16

Short head of biceps is the light house of the proximal humerus. It provides a clue to the orientation and attachment of all other structures. It passes through the groove between the greater and the lesser tuberosities although the anatomy may be frequently distorted in complex fractures and fracture dislocations.

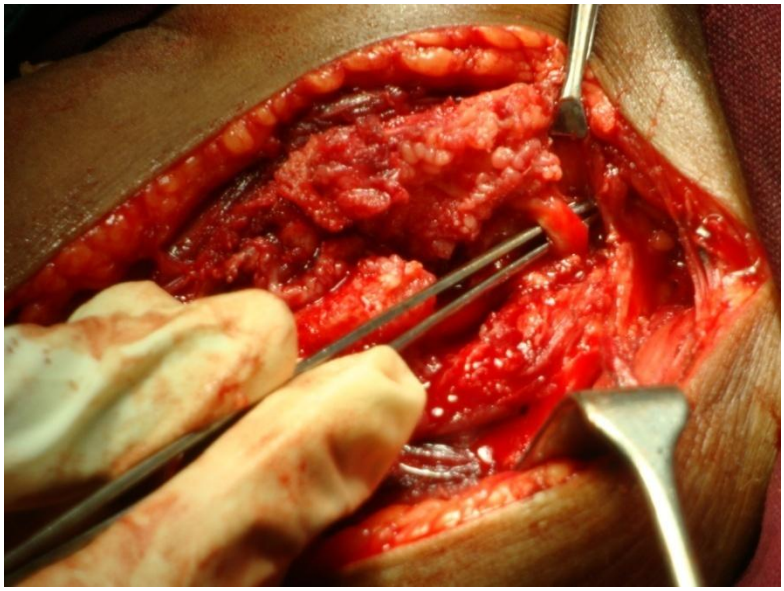


Figure – 17

The biceps tendon is traced from near the pectoralis major tendon insertion. This is then followed proximally. It passes through the rotator interval. If the rotator interval is enlarged, the origin of the tendon from the glenoid can be visualized.

The lesser tuberosity along with the tendon of the subscapularis is subsequently identified. If the fracture fragments are separated then the subscapularis pulls the lesser tuberosity medially and the greater tuberosity is displaced postero-laterally.

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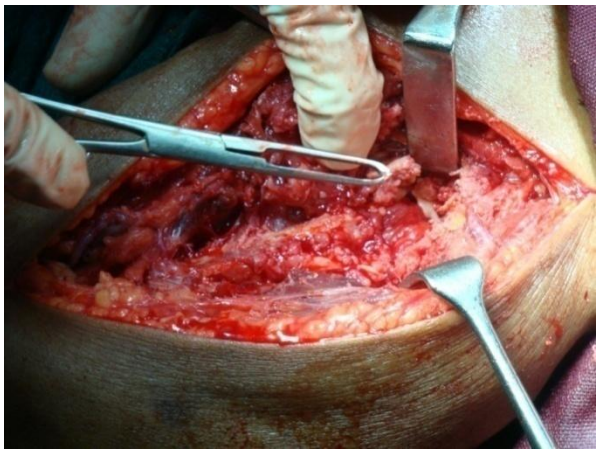


Figure – 18

Once the tuberosities are secured, the head is delivered.

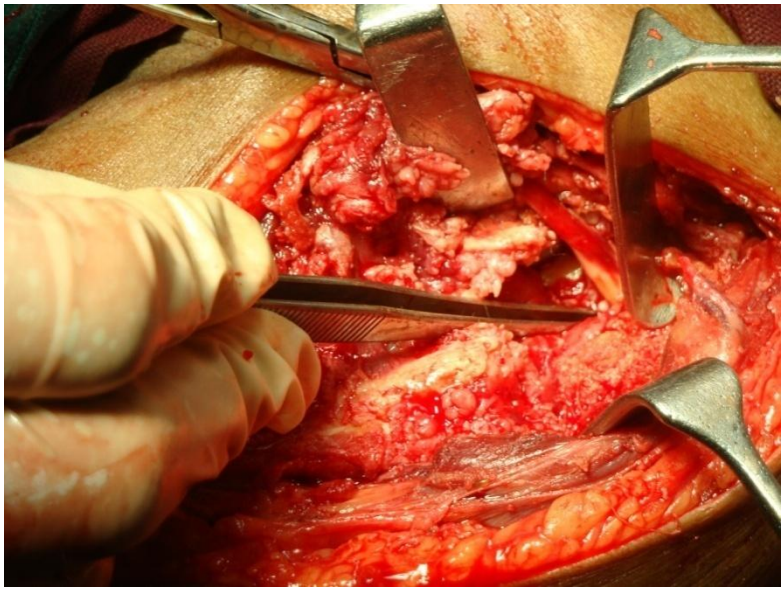


Figure – 19

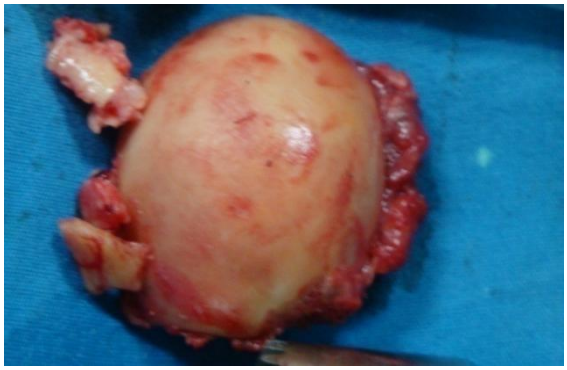


Figure – 20

The head is then sized using a sizer. The glenoid is then inspected for any erosion, which if identified necessitates glenoid component replacement.

Figure – 21

The humerus canal is serially reamed with 5,6,7 reamers. The tuberosity is secured with either 5# ethibond or 18 G SS wire. Trial prosthesis inserted.

RETROVERSION: The next step is determination of degree of retroversion. We have used the trans epicondylar axis as reference. The elbow is flexed 90^0 and the epicondylar axis is set to 0. We have set the retroversion between 20^0 and 30^0.

Figure – 22

PROSTHESIS HEIGHT: The appropriate height of the prosthesis and the seating are subsequently determined. The prosthesis when seated should allow

50% anterior and posterior translation and should not sink below the midpoint of the glenoid if traction is applied.

CEMENTATION: Cementation is done and the prosthesis is set at the measured height and version. Removal of the excess cement is done and the cement is allowed to dry.

REPAIR AND RECONSTRUCTION OF TUBEROSITIES: The tuberosities have to be attached to each other and the shaft through the prosthesis. Sometimes the tuberosity may need to be trimmed to be attached to the prosthesis. This may be achieved either through osteoperiosteal sutures or 18 GSS wire.

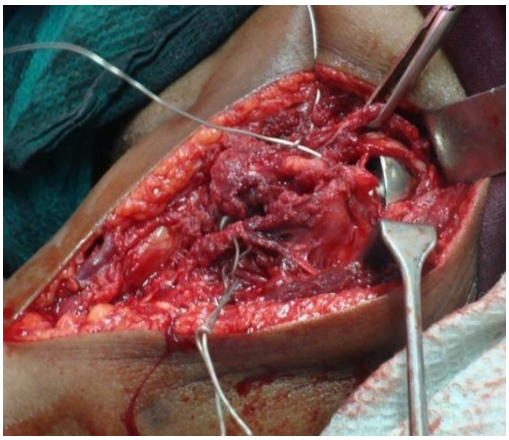


Figure – 23

CLOSURE : Thorough wound wash given. Wound closed in layers with drain in situ. Sterile dressing applied. Post operatively shoulder immobilizer applied.

Figure – 24

IMPLANTS AND INSTRUMENTS

Figure – 25

POST OPERATIVE PROTOCOL:

- IV antibiotics for 3 days.
- Oral antibiotics for 3 days.
- 2nd pod : drain removal
- 12th pod – suture removal

MOBILIZATION PROTOCOL:

- Immediate post op – immobilized in shoulder immobilizer till 15th post operative day
- **Phase I exercises** - 2 weeks
- **Range of motion for the elbow:**

  Remove the sling.

  With the elbow flexed and the affected arm in front of the body flex and extend the elbow

- **Improving the grip strength**

  To grip a soft ball, sequentially holding and releasing for 5 seconds

- **Flexion of the shoulder**

Lie down supine

Hold a stick in both the hands.

Take the stick slowly above the head, using the normal arm to guide the affected one only going as far as comfortable.

- **<u>Pendulum exercises :</u>**

Bend slightly and rest the normal arm on a steady surface such as a table or desk, and allow the operated arm to hang and dangle in front of the body. Swing gently the dangling arm from left to right and then in a clockwise and counter clockwise manner.

- **<u>PHASE 2</u>** - 6 WEEKS

- **Horizontal flexion stretch**

Raise operated arm to the height of the shoulder with the thumb pointing downwards

- **Extension of the shoulder**

Holding a small stick under the hand and gripping it behind the back. Then slowly attempt to push the stick further away from the back.

- **<u>Phase 3</u> - 6 MONTHS**

- Return to work with light duties only

- Isometric muscle strengthening exercises
- Apply gentle pressure and hold each exercise for 5 seconds, a series of 10 exercises, 3 times daily
- **Isometric flexion**

  Lift the affected arm forward, while resisting the movement using the normal arm.
- **Isometric extension**

  Push elbow backwards into a pillow.
- **Isometric adduction**

  After keeping the neck and shoulder blades at rest, squeeze the pillow kept between the 2 elbows.
- **Isometric external rotation**

  After keeping the elbow by the side, the forearm is used to press the wall in an outwardly direction.

POST OPERATIVE EVALUATION:

- Constant shoulder score
- UCLA score

CONSTANT SCORE [42]

Table I Subjective assessment of shoulder (35 total points possible)

Function	Points
Ability to work	0-4
Ability to engage in recreational activities	0-4
Ability to sleep	0-2
Ability to work at specific level	
Waist	2
Chest	4
Neck	6
Head	8
Above head	10
Pain	0-15

Table II Objective shoulder assessment (65 total points possible)

Activity	Points
Flexion and abduction (scored separately)	
>150°	10
121° = 150°	8
91° = 120°	6
61° = 90°	4
31° = 60°	2
Combined active external rotation	
Hand behind head, elbow forward	2
Hand behind head, elbow back	2
Hand on top of head, elbow forward	2
Hand on top of head, elbow back	2
Full elevation from top of head	2
Combined active internal rotation of hand	
Interscapular region	10
Inferior tip of scapula	8
Twelfth rib	6
Lumbosacral junction	4
Buttock	2
Lateral thigh	0
Strength	1/lb

Table - 1

UCLA SCORE [43]

Pain

1 - Pain that is always present and unbearable and does not subside even with strong medication

2 - Always present but bearable, occasionally strong medication required

4 - No or little pain present at rest; present even with light activities, and patient often takes salicylates

6 - Frequent pain that is present only with heavy activities

8 – Mild pain, occasionally

10 – Absence of pain

Function

1 - Inability to use the limb

2 - Only light activities are possible

4 - Capable of performing light household work or activities of daily living

6 - Household work, driving, shopping if possible; capable of grooming his/her hair, getting dressed and undressed, including wearing a bra

8 - Only slight restriction. Capable of working at a level above the shoulder

10 - Normal activities

Ventral active flexion

5 - More than 150^0

4 - 120^0 to 150^0

3 - 90^0 to 120^0

2 - 45^0 to 90^0

1 - 30^0 to 45^0

0 - Less than 30^0

Strength of active flexion

5 - Normal or grade 5

4 - Good or grade 4

3 - Average or grade 3

2 - Poor or grade 2

1 - Perceptible muscle contracture

0 - No contraction is perceived

Patient satisfaction

5 - Satisfied and better

0 - Dissatisfied and worse than before the surgery

Outcome evaluation

Satisfactory: ≥ 28

Unsatisfactory: ≤27

Observations

OBSERVATIONS

Sex Distribution:

Of the 20 patients, there were 9(45%) males and 11(55%) females.

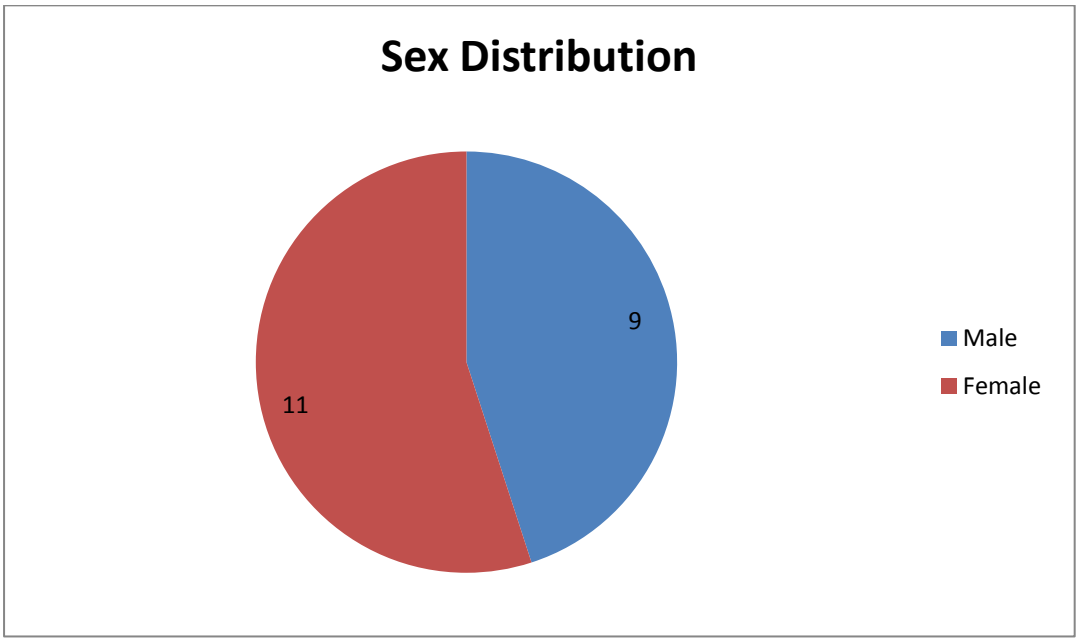


Figure – 26

Age distribution

The minimum age was 55 and the maximum age was 79, with a mean of 63.45 years

Table -2

S.No.	Range	Number of Patients	Percentage
1	55-64	9	45
2	65-74	10	50
3	>75	1	5

Occupation

The following table illustrates the occupation of the patients

S.No.	Occupation	No. of Patients
1	Labourer	12
2	Housewife	6
3	Policeman	1
4	Fisherman	1

Table - 3

Mode of Injury

The following table illustrates the various modes of injury

Table - 4

S.No.	Mode of injury	No. of patients	Percentage
1	RTA	9	45
2	Fall from floor level	10	50
3	Fall from height	1	5

Side of involvement

All 20 patients were right hand dominant individuals

Table - 4

S.No.	Side	Number of patients	Percentage
1.	Right	12	60
2.	Left	8	40

Associated injuries

A thorough examination revealed the following injuries

Table - 5

S. No.	Associated injuries	No. of patients	Percentage
1.	No associated injuries	18	90
2.	# both bones leg	1	5
3.	Superior inferior pubic rami #	1	5

Co-morbidities

Diabetes Mellitus (type 2) and hypertension were the co morbidities associated

Table - 6

Fracture Classification

S.No.	Co-morbidity	No. of patients
1.	Diabetes mellitus	8
2.	Hypertension	8

The patients were classified into the following fracture patterns based on Neer's classification

Table - 7

S.No.	Classification	No. of patients	Percentage
1.	3 part #	5	25
2.	4part #	4	20
3	3part# dislocation	4	20
4	4part# dislocation	4	20
5	3 part # with 2^0 Avascular necrosis	3	15

Time between injury and hospital admission

The time between injury and hospital admission ranged between 0 to 300 days (Mean: 47.7 days)

Table - 8

S. No.	Time interval	No. of patients	Percentage
1.	< 1 day	6	30
2.	1 to7 days	5	20
3.	8 to 30 days	3	15

4.	31 to 90 days	4	20
5.	≥91 days	3	15

Treatment History

9 of the 20 patients (45%) were treated initially by native bone setter before being to the hospital.

Time between admission into the hospital and surgery:

Time between admission and surgery ranged between 6 hours to 30 days (Mean: 9.9 days)

Patient positioning and approach:

i) All 20 patients were placed in supine position and all patients were placed under General anaesthesia with endotracheal tube. The humerus was approached anteriorly through a deltopectoral approach.

ii) Cephalic vein was lateralized in 19(95%) and medialized in 1(5%) patients.

Greater and Lesser tuberosity preservation:

i) Greater tuberosity was retained with soft tissue attachment in 19(95%) patients.

ii) Lesser tuberosity was retained with soft tissue attachment in 18(90%) patients.

Prosthesis:

Unipolar Neer's prosthesis was placed in 13 patients (65%) and a modular prosthesis in 7 patients (35%)

Size of prosthesis used:

Table - 9

S.No.	Size of prosthesis	Number of patients	Percentage
1.	34	3	15
2	36	5	25
3.	37	3	15
4	38	6	30
5	39	2	10
6.	40	1	5

Retroversion:

Retroversion of the prosthesis ranged between 20^0 to 25^0 (Mean 24^0).

Cementation:

Cementation was used in 19(95%) of the patients and uncemented prosthesis was used due to small medullary canal in 1 patient (5%). All 19 were cemented manually.

Cementation complications:

No cementation complications were observed.

Reconstruction of Tuberosities:

Table - 10

S.No.	Type of reconstruction	No. of patients	Percentage
1.	Prolene	15	75
2.	#5 ethibond	1	5
3.	SS wire	4	20

Anaesthetic Complications:

No anaesthetic complications were reported in any patients.

Blood Loss:

Blood loss ranged from 90ml to 650 ml (Mean: 187 ml)

Operative Time:

Operative time ranged from 75 minutes to 380 minutes (Mean: 116.5 minutes)

Shoulder immobilizer application:

Shoulder immobilizer was applied for 19(95%) patients. In 1 patient above elbow slab was applied in extension because of vascular repair and fasciotomy. Immobilizer was applied between 10-15 days (Mean: 13.3 days)

Drain:

Drain was left in place between 2-4 days (Mean: 2.15 days) and the drain amount collected ranged from 50ml-350ml (Mean 141.5 ml).

Blood Transfusion:

Intra and post operative blood transfusions ranged from 0 – 3 (Mean 1.25)

Suture Removal:

Suture removal ranged from 12 to 21 days (Mean: 12.8 days)

Swabs for culture sensitivity:

3 patients had discharge which was sent for culture sensitivity. 1 patient grew Pseudomonas aeroginosa, 1 patient grew coagulase negative staphylococcus aureus and 1 patient had no growth.

Associated injuries treated:

One patient with #both bones leg was treated with intra-medullary nailing and the one patient with superior inferior pubic rami # was treated conservatively.

Follow up

Follow up of the patients was done for a period of 6-30 months (average 16.55 months)

Outcome:

Outcome analysis was performed using Constant Murley score and UCLA score.

Pain

Table - 11

S.No.	Pain	No. of patients	Percentage
1.	None	8	40
2.	Mild	10	50
3.	Moderate	2	10
4.	Severe	0	0

Activity level

a) Unaffected sleep

Table - 12

S.No.	Undisturbed sleep	No. of patients	Percentage
1.	Yes	7	35
2.	No	13	65

b) Full recreation

Table - 13

S.No.	Full recreation	No. of patients	Percentage
1.	Yes	10	50
2.	No	10	50

c) Full work

Table - 14

S.No.	Full work	No. of patients	Percentage
1.	Yes	8	40
2.	No	12	60

3) Arm positioning

Table - 15

S.No.	Arm positioning	No. of patients	Percentage
1.	Up to the waist	0	0
2.	Up to the xiphoid	1	5
3.	Up to the Neck	2	10
4.	Up to Top of the Head	12	60
5.	Above Head	5	25

4) Strength of abduction: Strength ranged from 5-25 pounds (Mean 19.5 pounds)

5) Forward Flexion

Table - 16

S.No.	Forward flexion	No. of patients	Percentage
1.	31 to 60	2	10
2.	61 to 90	8	40
3.	91 to 120	4	20
4.	121 to 150	4	20
5.	151 to 180	2	10

6) Lateral elevation

Table - 17

S.No.	Lateral elevation	No. of patients	Percentage
1.	31 to 60	2	10
2.	61 to 90	8	40
3.	91 to 120	4	20
4.	121 to 150	4	20
5.	151 to 180	2	10

7) External rotation

Table - 18

S.No.	External Rotation	No. of patients	Percentage
1.	Hand is placed behind the head with the elbow pointing forward	1	5
2.	Hand is placed behind the head with the elbow pointing back	1	5
3.	Hand is kept on top of the head with the elbow	5	25

	pointing forward		
4.	Hand is kept on top of the head with the elbow pointing back	10	50
5.	Elevation fully possible	3	15

8) Internal rotation

Table - 19

S.No.	Internal rotation	No. of patients	Percentage
1.	Lateral Thigh	0	0
2.	buttock	0	0
3.	lumbosacral region	3	15
4.	waist	2	10
5.	T12 vertebra	8	40
6.	Interscapular region	7	35

Constant Score [56]:

The Constant score ranged from 31 to 98 with a mean of 67.45

Constant score for the opposite shoulder

The Constant score for the opposite side ranged from 49 to 100 with a mean of 93.5

Difference in constant scores had a mean of 26.05(Range: -16 – 67)

Grading of constant score [57]

Table - 20

S.No.	Outcome	No. of patients	Percentage

1.	Excellent	4	20
2.	Good	4	20
3.	Fair	5	25
4.	Poor	7	35

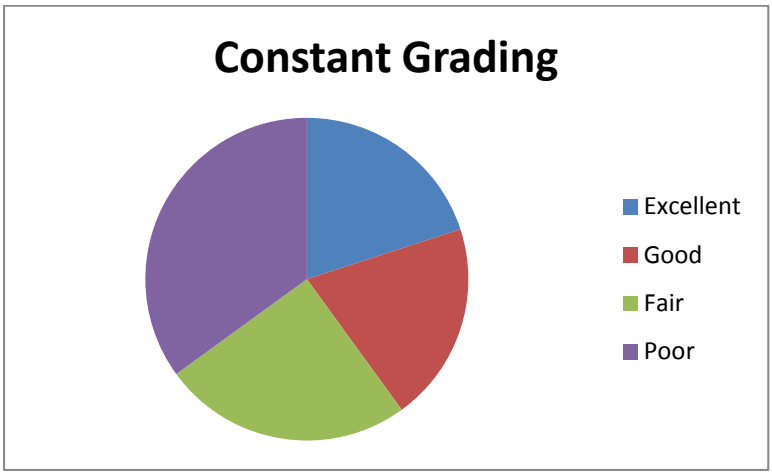


Figure - 27

UCLA score [58]:

1) Pain

Table - 21

S.No.	Pain	No. of patients	Percentage
1.	Pain is unbearable and always present; strong medication is required often	0	0
2.	Pain is bearable but is always present, strong medication is required occasionally	0	0
3.	No pain at rest, pain on performing light work, mild medication is used often	5	25
4.	Pain is present only on heavy activity or only a particular movement is performed, mild medication is	4	20

	used occasionally		
5.	Slight pain that is present occasionally	10	50
6.	Pain is absent	1	5

2) Function

Table - 22

S.No.	Function	No. of patients	Percentage
1.	Completely unable to use the affected limb	0	0
2.	Only light activities are possible	0	0
3.	Able to perform light household work or most of the activities of daily living	5	25
4.	Patient is able to carry out most of the house hold work including shopping and driving; able to correct the hair and to put on and remove dress	4	20
5.	Only slight restriction and is able to perform activities above the level of the shoulder	10	50
6.	Normal activity	1	5

3) Active forward flexion

Table - 23

S.No.	Active forward flexion	No. of patients	Percentage
1.	150°	2	10

2.	120 150	2	10
3.	90°-120°	6	30
4.	45°-90°	10	50
5.	30°-45°	0	0
6.	< 30 °	0	0

4) Forward flexion strength (manually tested)

Table - 24

S.No.	Strength of forward flexion	No. of patients	Percentage
1.	Grade V (normal)	2	10
2.	Grade IV (good)	2	10
3.	Grade III (fair)	6	30
4.	Grade II (poor)	10	50
5.	Grade I (muscle concentration)	0	0

5) Satisfaction of patients

Table - 25

S.No.	Patient satisfaction	No. of patients	Percentage
1.	Satisfied and better	19	95
2.	Not satisfied and worse	1	5

UCLA score: UCLA score ranged from 15 – 34 (Mean 24.7)

Grading [59]

Table - 26

S.No.	Grade	No. of patients	Percentage
1.	Satisfactory	11	55
2.	Unsatisfactory	9	45

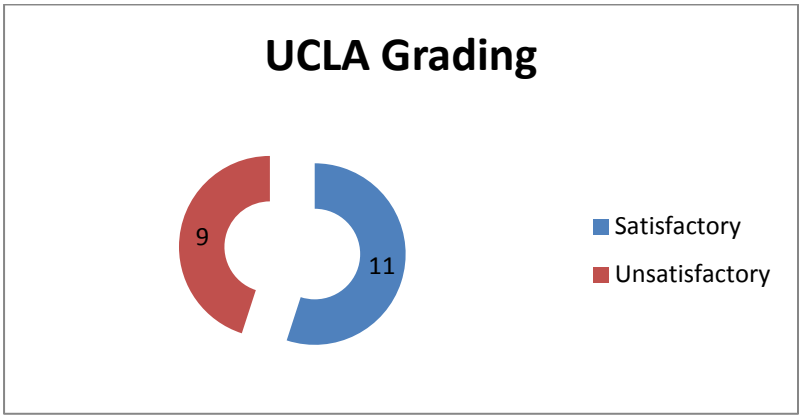


Figure - 28

Active Forward Flexion:

Active forward flexion ranged from 50^0 to 180^0 (Mean 100.5^0)

Active Abduction:

Active abduction ranged from 50^0 to 160^0 (Mean 90^0)

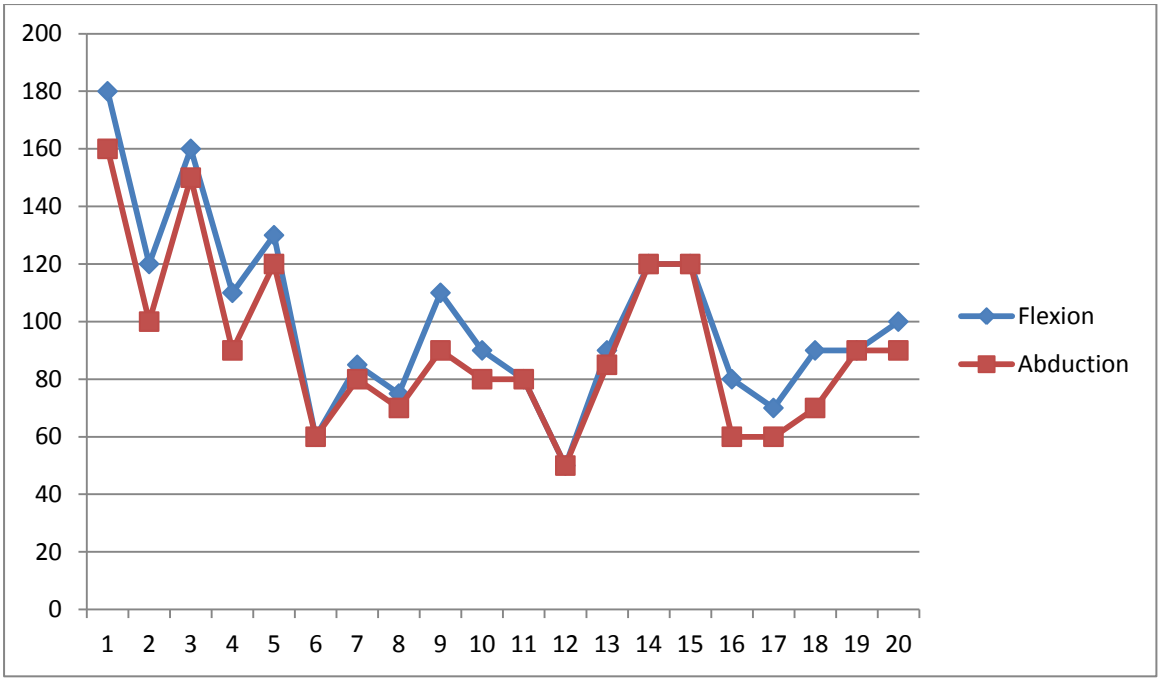


Table - 28

Complications:

a. 1 patient developed post operative radial nerve palsy. Radial nerve palsy did not recover at 6 months follow up. Patient was offered radial nerve exploration. Patient did not wish to have a second procedure

b. 1 patient was found to have an axillary artery thrombosis intraoperatively. Immediate vascular surgeon opinion was obtained.

The thrombus was found to be in the 3rd part of the axillary artery. Bypass grafting between 2nd part of the axillary artery and brachial artery was performed. Following successful bypass, forearm fasciotomy was performed. Patient was subsequently taken up for Split thickness skin graft on the 4th post-operative day. Patient had his upper limb placed in extension. Hence Shoulder immobilizer could not be applied and the patient was placed in above elbow slab in extension.

c. Proximal migration of the affected shoulder was seen in 2 patients (20%)

d. Infection was observed in 2 patients (20%). Cultures were sent from both the patients and empirical antibiotics started. Definitive antibiotics were started based on the antibiotic sensitivity pattern

   i) One patient grew Pseudomonas aeroginosa which was sensitive to ciprofloxacin. Since wound did not respond adequately to antibiotics, patient was taken up for a wound wash. Subsequently wound settled and suture removal was done on the 21st post operative day. Serial cultures sent were negative.

   ii) One patient grew coagulase negative Staphylococcus aureus sensitive to vancomycin. Patient responded to the course of antibiotics and subsequent wound healing was satisfactory.

e. One patient had delayed wound healing, cultures did not grow any organism, and patient was converted to empirical Ciprofloxacin i.v and then oral ciprofloxacin.

f. One patient developed shoulder dislocation at 6 months post op due to a subsequent unrelated trauma, which was reduced and immobilized for a period of 6 weeks. Mobilization was begun as per initial post operative protocol.

Results

RESULTS

From the above observations, the following results and conclusions may be drawn.

1. The incidence of complex fracture patterns of the proximal humerus has a slight female preponderance (11:9)

2. The dominant hand is involved 1.5 times more often. (R>L)

3. Fall from floor level is the commonest mode of injury which suggests an osteoporotic undercurrent

4. One patient had a fracture of both sides but had a gap of 1 year between the 2 injuries. Both injuries were sustained by falls inside the house.

5. 6 patients reported to the hospital within 24 hours of injury (30%). However 3 patients presented later than 3 months. The mean was approximately 1.5 months, suggesting patients try native treatment before reporting to the hospital. (40%)

6. The patients when classified according to the fracture pattern were distributed evenly.

7. Time between hospital admission and surgery ranged from 12 hours to 30 days, with a mean of 9.9 days. This reflected the co morbidities present and the delay in bringing the patient to anaesthetic fitness.

8. 2 patients had associated fractures (10%) and one of them required addition surgical management.

9. All patients were placed under General anaesthesia, with patients being in supine position and were approached through a deltopectoral approach.

10. Cephalic Vein was lateralized in 19 and medialized in 1 patient.

11. The greater tuberosity with its soft tissue attachment was preserved in 19 patients, but this does not significant affect the outcome (p=0.58)

12 The lesser tuberosity with its soft tissue attachment was preserved in 18 patients, but this does not significant affect the outcome (p=0.66)

13. 36 and 38 were the commonest prosthesis sizes used.

14. The retroversion placed was between 20^0 and 25^0 with a mean of 24^0

15. Cementation was performed in 19(95%) of the patients, one patient had a small medullary canal, hence cementation abandoned. Cementation was done manually in all patients.

16. None of the patients developed any complications due to cementation.

17. Most common method of reconstruction of tuberosities was by use of prolene (75%).

18. None of the patient had any anaesthesia related complications.

19. The blood loss ranged between 90 ml and 650 ml with a mean of 187 ml. However this is not a true reflection of the average blood loss expected during hemiarthroplasty because the mean has been affected by an outlier value of 650 ml, which was the blood loss in the patient who had an axillary artery thrombosis and had a vascular bypass done. The mean blood loss would have been 162 ml.

20. The operative time ranged from 75 minutes to 6 hours 20 minutes, with a mean of 116 minutes. Just as with the blood loss, the outlier value was of the patient with a bypass grafting, which if removed would reduce the mean operative time by 15 minutes.

21. We opted not to test the range of movements intra-operatively.

22. Shoulder immobilizer was applied in all but 1 patient, which was left on for a period of 10-15 days (Mean: 13 days).

23. Drain was removed on the 2nd post operative day in 18 patients (90%), one patient had her drain removed on the 3rd day and 1 patient on the 4th day when he was taken up for split skin grafting.

24. Drain amount ranged from 50-350 ml (mean 141.5 ml).

25. Most patients required at least one blood transfusion either in the intra operative or the post operative period (range 0-3)

26. Wounds were swabbed for culture and antibiotic sensitivity in 3 patients (15%)

27. 16 patients(80%) had an uneventful hospital stay. 2 patients required a 2^{nd} surgery, 1 had a wound wash, the other a split thickness skin graft. 1 patient developed a radial nerve palsy, one developed a delayed wound healing.

28. The constant scores ranged from 31 to 98, with a mean of 67.45.

29. UCLA scores ranged from 15 to 30, with a mean of 24.2

30. Proximal migration of the arm was the most common complication observed in 2 patients (10%).

31. Active forward flexion ranged from 50^0 to 180^0 with a mean of 100^0

32. Active abduction ranged from 50^0 to 160^0 with a mean of 93^0

33. The patients were graded into excellent, good, fair and poor based on the constant scores and there were 4,4,5,7 patients respectively.

34. The patients were graded into satisfactory and unsatisfactory based on UCLA scores and there were 11 patients in the satisfactory category and 9 patients in the unsatisfactory category.

Tests of statistical significance

Based on the above observations tests of statistical significance was performed (chi square test, unless specified).

1. The composite constant grades (excellent, good, fair, poor) were not significantly affected by

i) Fracture classification (p=0.80)

ii) Time since injury (p=0.40)

iii) Sex of the patient (p=0.7)

iv) Age of the patient (p= 0.74)

v) Operative time (p= 0.39)

vi) Method of reconstruction of tuberosity (p = 0.12)

2. The subcomponents of the constant scores were tested for significance against the various factors for significance

a) Pain

i) Side of injury does not significantly affect the outcome (p=0.75)

ii) Time since injury does not significantly affect the outcome (p=0.64)

iii) Sex of the patient does not significantly affect the pain outcome (p=0.43)

iv) Age of the patient does not significantly affect the outcome (p=0.20)

v) Operative time significantly affects the outcome, patients with shorter operative times have lesser post operative pain (p= 0.02)

vi) Method of reconstruction of tuberosity does not significantly affect the outcome (p=0.73)

b) Arm positioning

Arm positioning was not significantly affected by

i) Side of injury (p=0.47)

ii) Time since injury (p=0.51)

iii) Sex of the patient (p=0.21)

iv) Age of the patient (p=0.39)

v) Operative time (p= 0.12)

vi) Method of reconstruction of tuberosity (p=0.77)

c) Forward flexion

Forward flexion was not significantly affected by

i) Side of injury (p=0.68)

ii) Time since injury (p=0.09)

iii) Sex of the patient (p=0.52)

iv) Age of the patient (p=0.77)

v) Operative time (p= 0.55)

vi) Method of reconstruction of tuberosity (p=0.30)

d) External rotation

External rotation was not significantly affected by

i) Side of injury (p=0.77)

ii) Time since injury (p=0.42)

iii) Sex of the patient (p=0.59)

iv) Age of the patient (p=0.37)

v) Operative time (p= 0.12)

vi) Method of reconstruction of tuberosity (p=0.91)

e) Internal rotation

Internal rotation was not significantly affected by

i) Side of injury (p=0.37)

ii) Time since injury (p=0.83)

iv) Age of the patient (p=0.41)

v) Operative time (p= 0.07)

vi) Method of reconstruction of tuberosity (p= 0.8)

There was significant association between sex of the patient and internal rotation (p=0.05), with males having better internal rotation.

Discussion

DISCUSSION

Proximal humeral fractures are common in the elderly patients. However a majority of them are undisplaced or minimally displaced and may be treated conservatively with good return of function and minimal complications. However about 1/5th of the patients with displaced fractures may be candidates for surgical management [64].

Hemiarthroplasty is considered the standard of care for patients who present with displaced complex fracture patterns or the presence of ischaemic necrosis of the humeral head following a fracture. However there is a paucity of literature about the risks and benefits and functional outcome of patients after hemiarthroplasty in the Indian especially the South Indian population. This study has been designed to answer these questions.

Twenty patients admitted to our institute matching the inclusion criteria have been included in the study after obtaining an informed written consent regarding the treatment options available, the process of hemiarthroplasty, the possible complications and the post operative protocol that will be followed including the need for prolonged rehabilitation.

Numerous studies show a strong female preponderance for these fractures. But in our study the female to male ratio is 11:9

The mean age of patients enrolled in our study was 63.4 years. This is lower than the studies of Anjum et al [65] and Pavlopoulos et al [66] in which the mean age of the patients were 77 and 73 respectively. Since the life expectancy of the UK and Greece, in which these studies were conducted 80.1 and 79.5 respectively, it compares relatively well with our study in which the life expectancy of an average Indian is 64.7 years[67].

The majority of the cases included in our study are labourers and house wives, which is representative of the population above 60 years of age in our country.

Fall from floor level and from RTA have been distributed almost equally suggesting the fact that osteoporosis plays a significant role in the pathogenesis of these fractures.

Since most of the patients included in the study were about 60 years of age, there were significant co-morbidities present in the form of diabetes and hypertension which prolonged the time between hospital admission and surgery.

The side of the patient involved was right side (dominant) in 60% of the patients. This compares with other studies [65], [66], and [68] in which the dominant side was involved in 55.7% and 50% and 53% respectively.

The patients were distributed equally among the various types of fractures which in contrast to other studies [65], [66], [68], in which the four part fractures the 3 part and 4 part fractures were commoner respectively.

The mode of injury was equally distributed between Road traffic accidents and simple fall from floor level, which was unlike other falls where falling from the floor level was the common mode of injury.

The time between injury and hospital admission had a mean of 47 days. This indicates the high prevalence of patients seeking treatment from native bone setters. Although 9 patients(45%) of the patients presented within 1 week from the time of injury, 3(15%) presented as late as 3 months. 11 patients (55%) had at least 1 sitting of treatment with a native practitioner before presenting to us.

Unipolar prosthesis was used in 13(65%) of the patients and modular 7(35%). 19 cases were cemented and in 1 patient no cementation was done.

Prolene was used for the reconstruction in 15(75%) of the patients, in 4 patients stainless steel wiring was used and 1 patient was reconstructed using #5 ethibond.

There were no complications seen after cementation or there were no related anaesthetic complications.

One patient had an axillary artery thrombosis detected intra operatively. Urgent vascular opinion was obtained. Vascular bypass was done and Hemiarthroplasty completed. Forearm fasciotomy was performed. Blood loss was 650 ml and operating time was 380 minutes. This value significantly affected the mean operative time and the blood loss. One patient developed post operative radial nerve palsy.

Patients were placed on post operative immobilization with a shoulder immobilizer, in all but one patient. Patients required intra operative and/or post operative transfusions ranging from 0 to 3 with a mean of 1.25 per patient.

Outcomes were analysed using Constant Murley and UCLA scores.

Reference	Number of cases	Follow up(months)	Mean age (years)	Constant score
Ambacher et al[77]	27	42	69	65
Becker et al[79]	27	45	67	45
Boileau et al	66	27	66	56
Boileau et al	43	29	68	60
Bosch et al[14]	40	43	68	54.2
Boss et al[73]	20	32	77	52
Christoforakis et al[79]	26	50	65	70.4
Demirhan et al[75]	32	35	58	68

Kollig et al[74]	46	62	60	66
Kralinger et al[68]	167	29	71	55.4
Reuther et al[71]	56	39	71	46
Zyto et al[72]	36	12.4	72	57.5
Loew et al[69]	21	29.3	74.1	51.5
Mehlhorn et al[74]	26	17	70.3	52
Gronhagen et al[70]	46	53	72	42
OUR STUDY	**20**	**16.55**	**63.45**	**67.45**

Based on the above studies, our study compares favourably with the other international studies and proves that Hemiarthroplasty is a viable option in elderly Indian patients with complex fracture patterns

The composite outcomes were measured against the various parameters such as age distribution of the patient, sex, time since injury, classification of fracture or the operative duration, none of these factors significantly affected the outcome. This was in contrast to other studies where the time between injury and the surgery was inversely related to the outcome. Based on this study it may be inferred that Hemiarthroplasty may be considered even if the patient presented late to the hospital.

When the subgroups of Constant score are analysed 17(85%) of the patients reported only no pain or mild pain. This compares favourably with most of the other studies. Pain outcomes were measured against the various

parameters such as age distribution of the patient, sex, time since injury, classification of fracture or the operative duration, none of these factors significantly affected the outcome except operative time. Increased operative time was associated with increase in post operative pain. This finding has not been reported in any of the other studies and needs further investigation. Relief of pain that Hemiarthroplasty provides to the patient may be considered to be a stand alone indication for surgery.

13 (65%) patients had no interruption of sleep, 10 could return to recreational activities while 8(40%) returned to pre fracture occupation, this was slightly lower than Pavlopoulos et al who reported around 65% in each category.

As for hand positioning was concerned, all but 1 patients were able to reach above chest height, which was similar to Kralinger et al [68]. When this was measured against the various parameters such as age distribution of the patient, sex, time since injury, classification of fracture or the operative duration, none of these factors significantly affected the outcome.

10 patients had active forward elevation of $>90^0$ and 10 $<90^0$. The mean was found to be 100^0 whereas in abduction the range was found to be similar with a mean of 93^0. Tanner and Cofield [10] reported active abduction of 100^0 whereas Goldman et al [80] reported active forward flexion of 107^0 which is similar to those obtained in our study. The range was slightly lower than the

study of Pavlopoulos et al in which 68% of the patients had anterior and lateral elevation $>90^0$.

When the anterior and lateral elevation were measured against the various parameters such as age distribution of the patient, sex , time since injury, classification of fracture or the operative duration, none of these factors significantly affected the outcome.

50% of the patients were able to place the hand on top of their heads with the elbow back and 15% of the patients were able to lift it above the head, this compared similarly with the study of Pavlopoulos et al. However none of the factors had prognostic significance.

75% of the patients were at least able to reach the T12 vertebra which was better than the results of Pavlopoulos et al. When various factors were compared there was a strong statistical association between male sex and improved internal rotation.

According to UCLA scoring, 55 % of the patients had no or mild pain that did not require salicylates, only 5 patients required frequent salicylates. 19 patients (95%) of the patients were satisfied with the surgery and only 1 person was dissatisfied.

1 patient developed post operative radial nerve palsy. However there were no axillary or musculocutaneous nerve palsy. 2 patients had superficial

infection and 1 of them required wound wash. 1 patient required split skin grafting for the closure of fasciotomy wound. This was comparable to the outcomes presented in Plausinis et al [81]. However there were no dislocations or glenoid degenerative changes. 10% of the patients had proximal migration which was in the suggested range of 0- 23 %.

70 % of the patients had uncomplicated hospital stay. Thus Hemiarthroplasty provides excellent provides excellent pain relief and moderate return of function which is similar to most other international studies.

Conclusion

CONCLUSION

Hemiarthroplasty provides an efficient option for treatment of complex fractures of the proximal humerus. There is excellent pain relief and moderate return of function in elderly patients with minimal complications. However a study with larger number of patients with long term follow up is needed before the conclusions can be generalized to the population.

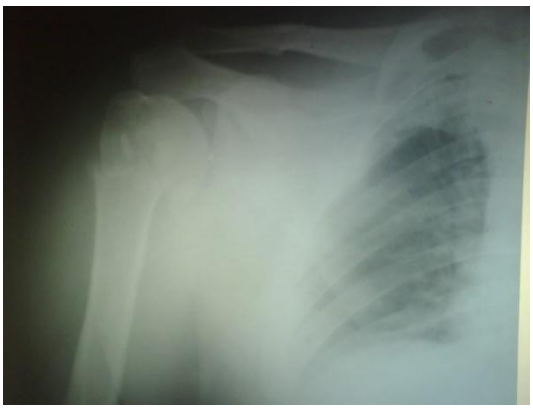
Illustrations

ILLUSTRATIONS

Case 1:

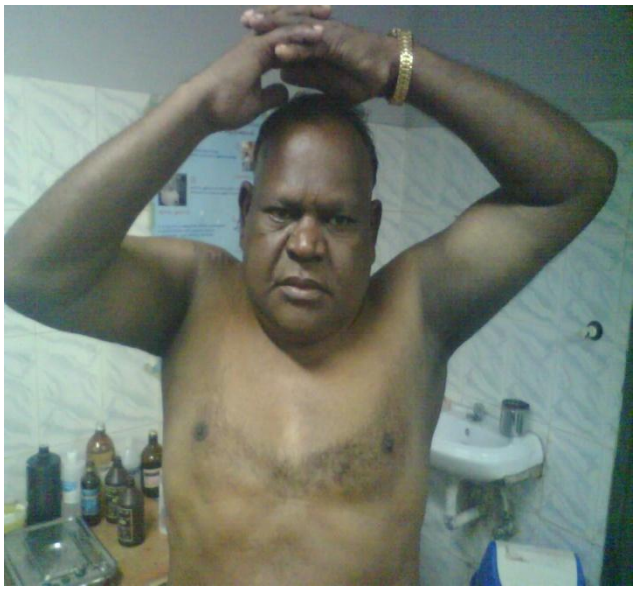
A 59 year old male, a fisher man by occupation, presented with history of RTA, 3 ½ months before, he took treatment from a native bone setter where 3 plasters where applied. He was diagnosed to have 3 parts fracture with avascular necrosis of the humeral head

After 2.5 years of follow up, patient has a constant score of 98(excellent), and UCLA score of 34(satisfactory).

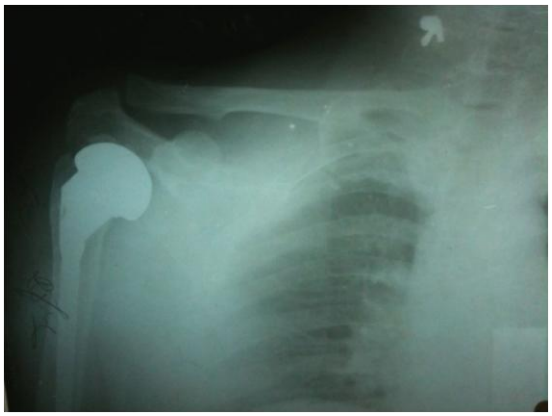


Pre op X ray

Pre op CT



2 months follow up



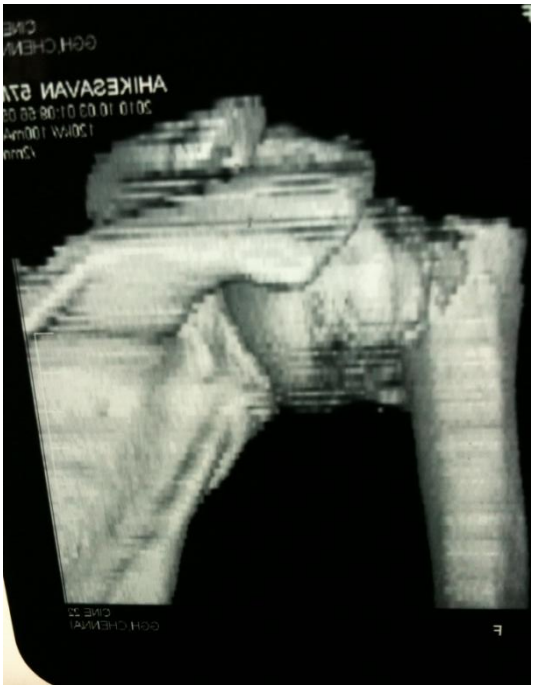
2 years follow up

Case 2:

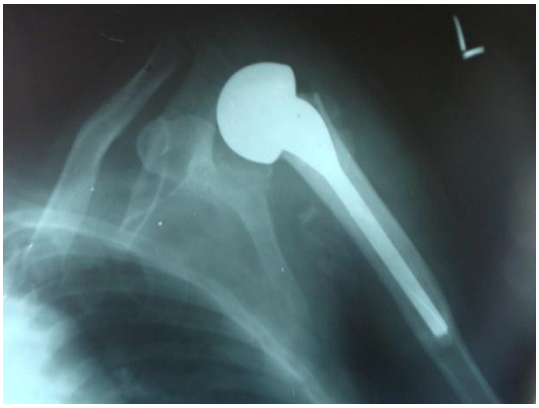
A 59 year old male, a labourer by occupation, presented with history of RTA, 1 day before, he sustained a 3 part fracture of the proximal humerus and a fracture both bone leg.

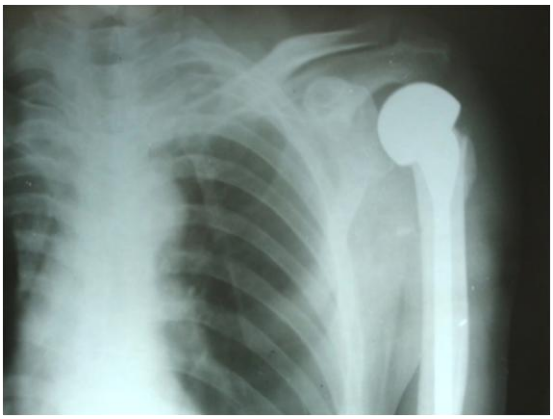
Hemiarthroplasty was followed by interlocking intramedullary nailing for tibia.

After 2 years of follow up, patient has a constant score of 98(excellent), and UCLA score of 30(satisfactory).



Pre op





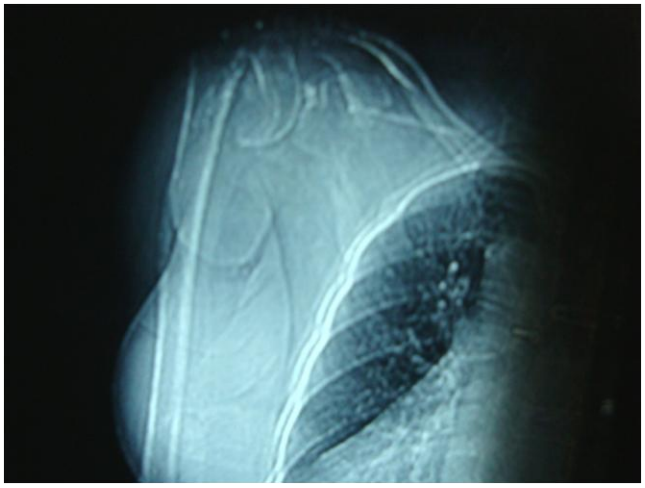
Post op

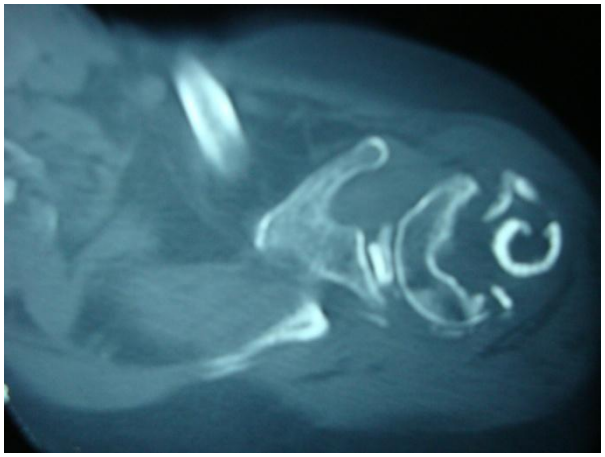
2 years follow up

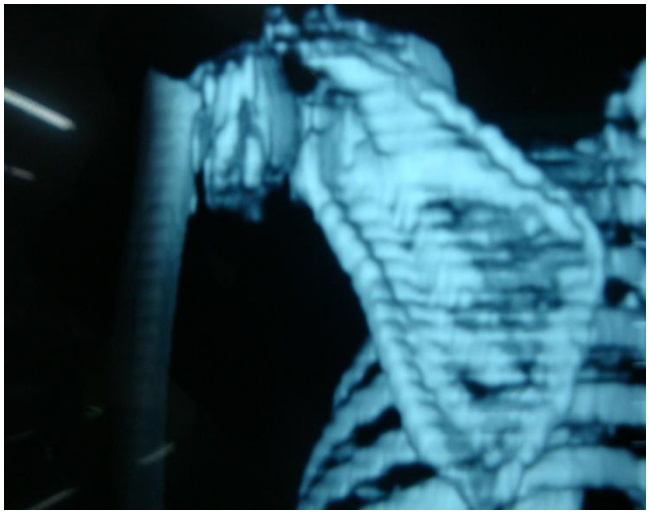
Case 3:

A 70 year old female , a labourer by occupation , presented with history of RTA, 2 months before, she had taken treatment from a native bone setter where 2 plasters where applied. He was diagnosed to have 4 part fracture of the humeral head

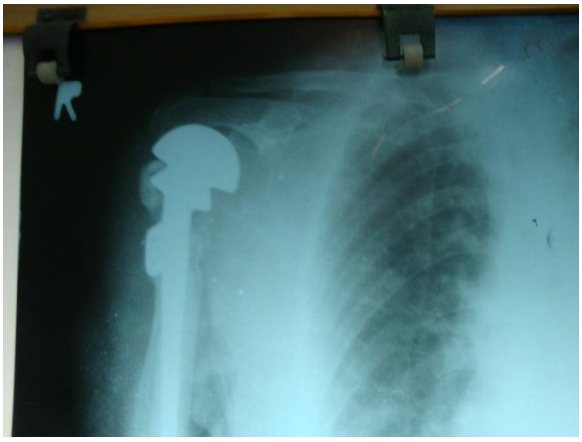
After 16 months of follow up, patient has a constant score of 56(Δ constant: 42, poor), and UCLA score of 20(unsatisfactory).







Pre op



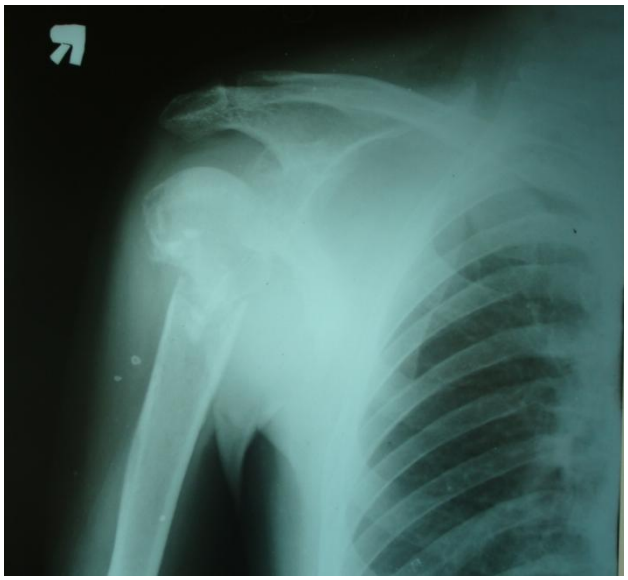
16 months follow up

Case 4:

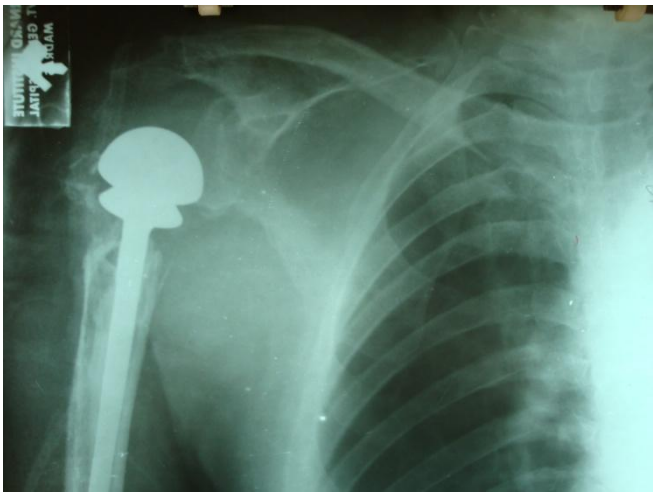
A 55 year old male , a labourer by occupation , presented with history of self fall from height, 2 days before, he was diagnosed to have 3 part fracture dislocation with avascular necrosis of the humeral head.

Patient developed post operative radial nerve palsy. He showed no signs of improvement of the radial nerve palsy and at 6 months, refused exploration.

After 23 months of follow up, patient has a constant score of 31(Δ constant: 67, poor), and UCLA score of 18(unsatisfactory).



Pre op



Post op

1 yr follow up

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Annexures

MASTER CHART

Pt.No	Age	Sex	Side	E	F	G	H	I	J	K	L	M
1	59	M	R	fisherman	RTA	Nil	10py + occ	0	0	3.5 months	y	y
2	66	F	L	housewife	Floor	ht*15	Nil	0	0	6hours	y	y
3	70	M	L	labourer	RTA	Nil	15py + occ	# BB leg	0	1 day	y	y
4	70	F	L	labourer	floor	Dm*15-oha/reg	Nil	0	0	2 weeks	y	y
5	66	M	R	police	RTA	ht*10y-regular	occ alc	0	0	2days	y	y
6	55	M	R	labourer	Height	Nil	10py	0	0	2days	y	y
7	65	M	R	labourer	RTA	dm+ht*15-reg	10py+ 1/wk	0	0	2.5months	y	y
8	60	F	L	labourer	RTA	Nil	Nil	0	0	5 days	y	y
9	65	M	R	labourer	floor	dm;irreg*12-oha	125 py	0	0	14days	y	y
10	66	F	R	housewife	floor	ht*16-reg	Nil	0	opp prox humerus	1 day	y	y
11	70	F	L	labourer	RTA	newly diagnosed ht	Nil	0	0	2 months	y	y
12	65	F	R	housewife	floor	dm*10 irreg,ht*14irreg	Nil	0	0	5.5 months	y	y
13	79	F	R	housewife	floor	ht*10-reg	Nil	0	0	0 days	y	y
14	56	F	R	housewife	floor	dm*10,ht*10 regular	Nil	0	0	3 days	y	y
15	62	M	L	labourer	RTA	Nil	10py + occ	SIPR	0	0 days	y	y
16	55	M	R	labourer	floor	dm*5 oha,reg	occ,occ	0	0	7 days	y	y
17	55	F	R	labourer	RTA	Nil	Nil	0	0	1 day	y	y
18	70	F	L	labourer	Floor	dm*10 reg	Nil	0	0	3 months	y	y
19	55	M	L	labourer	floor	dm 15 reg	occ,occ	0	0	2.5 months	y	y
20	60	F	R	housewife	RTA	Nil	Nil	0	0	10 months	y	n

Pt.No	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA
1	3part#-avn	3part#-avn	15 days	supine	etga	anterior	deltopec	M	y	y	39	20	y	0
2	4	4	12 hours	supine	etga	anterior	deltopec	L	y	y	36	25	y	0
3	3	3	14 days	supine	etga	anterior	deltopec	L	y	y	38	25	y	0
4	3#disl	3#disl	15days	supine	etga	anterior	deltopec	L	y	y	34	25	y	0
5	4	4	3days	supine	etga	anterior	deltopec	L	y	y	38	20	N	n/a
6	3#disl	3#disl	7 days	supine	etga	anterior	deltopec	L	y	y	36	25	y	0
7	4#disl	4#disl	14 days	supine	etga	anterior	deltopec	L	y	y	36	25	y	0
8	3#disl	3#disl	16days	supine	etga	anterior	deltopec	L	y	y	36	20	y	0
9	3	3	7 days	supine	etga	anterior	deltopec	L	y	y	38	25	y	0
10	3	3	1 day	supine	etga	anterior	deltopec	L	y	y	38	25	y	0
11	4	4	30 days	supine	etga	anterior	deltopec	L	y	y	34	25	y	0
12	3part#-avn	3part#-avn	15days	supine	etga	anterior	deltopec	L	n	n	38	25	y	0
13	4	4	1 day	supine	etga	anterior	deltopec	L	y	y	36	25	y	0
14	3	3	4 days	supine	etga	anterior	deltopec	L	y	y	34	20	y	0
15	4#disl	4#disl	10 days	supine	etga	anterior	deltopec	L	y	y	40	25	y	0
16	4#disl	4#disl	12 hours	supine	etga	anterior	deltopec	L	y	y	38	25	y	0
17	3#disl	3#disl	9 days	supine	etga	anterior	deltopec	L	y	y	37	25	y	0
18	4#disl	4#disl	7 days	supine	etga	anterior	deltopec	L	y	y	37	25	y	0
19	3	3	15 days	supine	etga	anterior	deltopec	L	y	y	39	25	y	0
20	3#-avn	3#-avn	14 days	supine	etga	anterior	deltopec	L	y	n	37	25	y	0

Pt.No	AB	AC	AD	AE	AF	AG	AH	AI	AJ	AK	AL	AM	AN
1	1st	prolene	0	300	90	n	y	y	15	2	100	12	tax/ak5+ cip.met 5
2	1st	prolene	0	120	90	n	y	y	10	2	50	12	tax/ak3+ cephal 5
3	1st	prolene	0	200	120	n	y	y	14	2	200	21	tax/ak/metro10+cipro7
4	1st	ethibond	0	250	120	n	y	y	15	2	90	12	tax/ak/metro10+iv cipro7 + oral cip 7
5	n/a	prolene	0	90	75	n	y	y	15	2	120	12	tax/ak/metro10+cipro7
6	1st	prolene	0	200	135	n	y	y	10	2	150	12	tax/ak/metro7+ceph 7
7	1st	ss	0	650	380	n	n	ae slab	15	4	350	15	tax/ak/metro7 + iv vanco 7 + clin 7
8	1st	prolene	0	110	95	n	y	y	12	2	150	12	taxim/gm/metro7+oral cipro/metro7
9	1st	ss	0	130	90	n	y	y	12	2	190	13	taxim/ak/metro7+oral cipro/metro7
10	1st	prolene	0	180	110	n	y	y	15	3	150	13	taxim/gm/metro7+oral cipro/metro7
11	1st	prolene	0	200	140	n	y	y	15	2	100	12	taxim/gm/metro7+oral cipro/metro7
12	1st	prolene	0	150	120	n	y	y	12	2	150	14	taxim/gm/metro7+oral cipro/metro7
13	1st	prolene	0	150	90	n	y	y	15	2	150	12	taxim/gm/metro7+oral ceph/metro7
14	1st	prolene	0	130	80	n	y	y	15	2	130	12	taxim/gm/metro7+oral cipro/metro7
15	1st	prolene	0	110	90	n	y	y	10	2	150	12	taxim/gm/metro7+oral cipro/metro7
16	1st	prolene	0	200	95	y	y	y	15	2	130	12	taxim/gm/metro7+oral ceph/metro7
17	1st	prolene	0	120	90	n	y	y	12	2	100	12	taxim/gm/metro7+oral cipro/metro7
18	1st	ss	0	150	120	n	y	y	12	2	120	12	taxim/gm/metro7+oral cipro/metro7
19	1st	prolene	0	150	130	n	y	y	15	2	150	12	taxim/gm/metro7+oral cipro/metro7
20	1st	ss	0	150	75	n	y	y	12	2	100	12	taxim/gm/metro7+oral cipro/metro7

Pt.No	AO	AP	AQ	AR	AS	AT	AU	AV	AW	AX	AY	AZ	BA	BB
1	ND	N/A	n	healthy	30	98	34	0	180	160	100	2	excellent	SAT
2	ND	N/A	n	healthy	26	49	20	0	120	100	65	16	good	UNSAT
3	ps.ar	il nailing	y	wound wash 15d	26	98	30	superficial infection	160	150	100	2	excellent	SAT
4	no growth	N/A	n	delayed wound healing	24	70	21	delayed wound healing	110	90	96	26	fair	UNSAT
5	ND	N/A	n	healthy	24	92	27	0	130	120	100	8	excellent	SAT
6	ND	N/A	n	radial nerve palsy	23	31	18	radial nerve palsy	60	60	98	67	poor	UNSAT
7	cons	N/A	n	axillary artery thrombosis/bypassgrafting+ssg	22	43	15	proximal migration	85	80	100	57	poor	UNSAT
8	ND	N/A	n	healthy	21	57	23	dislocation due to subsequent trauma	75	70	96	39	poor	UNSAT
9	ND	N/A	n	healthy	18	75	27	0	110	90	98	23	fair	SAT
10	ND	N/A	n	healthy	16	62	27	0	90	80	49	-13	excellent	SAT
11	ND	N/A	n	healthy	15	56	20	0	80	80	98	42	poor	UNSAT
12	ND	N/A	n	healthy	13	32	18	proximal migration	50	50	96	64	poor	UNSAT
13	ND	N/A	n	healthy	13	64	26	0	90	85	96	32	poor	UNSAT
14	ND	N/A	n	healthy	12	83	29	0	120	120	98	15	good	SAT
15	ND	N/A	y	healthy	12	85	28	0	120	120	96	11	good	SAT
16	ND	N/A	n	healthy	9	60	25	0	80	60	98	38	poor	UNSAT
17	ND	N/A	n	healthy	8	80	28	0	70	60	100	20	good	SAT
18	ND	N/A	n	healthy	7	70	23	0	90	70	96	26	fair	UNSAT
19	ND	N/A	n	healthy	6	73	27	0	90	90	94	21	fair	SAT
20	ND	N/A	n	healthy	6	71	28	0	100	90	96	25	fair	SAT

LEGEND

PRE OP

E – Occupation

F - Mode of injury

G - Comorbidities

H - Personal Habits

I - Other Associated Injuries

J - Previous h/o osteoporosis/ insufficiency fractures

K - Time from injury to admission

L - X Ray

M - CT

N - Neer's classification

O - Final Diagnosis

INTRA OP

P - Time between hospital admission and surgery

Q - Position

R - Anaesthesia

S -Incision

T -Approach

U - Cephalic Vein(medialized or lateralized)

V – Greater tuberosity attachment preserved

W – Lesser tuberosity attachment preserved

X - Head size

Y - Version

Z –Cementation

AA -Cementation complications

AB - Type of cementation

AC -Type of reconstruction

AD - Anaesthetic complication

AE - Blood loss

AF - Operating Time

AG - Intra operative range of movements tested

AH - Shoulder immobilizer applied

POST OP

AI - Shoulder immobilizer applied

AJ - No. of days

AK – Drain Removal

AL - Drain Amount

AM - Suture removal

AN - IV/ORAL antibiotics

AO -pus c/s if any

AP - Associated fractures fixed

AQ - Associated injuries treated

AR - Discharge status

FOLLOW UP

AS - Follow up in months

AT- Constant score

AU -UCLA score

AV - Complications

AW - Flexion

AX - Abduction

AY - normal side constant score

AZ - diff between affected and normal constant score

BA - outcome(constant)

BB - outcome(UCLA)

ABBREVIATIONS USED

M – Male F – Female

R – Right L – Left

RTA – Road Traffic accident

DM – Diabetes Mellitus

HT – Hypertension

Py – Pack years

Occ – Occasionally

Y = yes

N = no

AK = Amikacin

GM = Gentamycin

Cip = Ciprofloxacin

M = Metronidazole

Ps.ar = Pseudomonas aeroginosa

Cons = Coagulase negative staphylococcus aureus

ND = Not done

Sat= Satisfactory

Unsat = Unsatisfactory

PROFORMA

Pre-Operative

Name: Age/Sex: Date of Admission:

Nature of Injury:

Side of Injury: Right ☐ Left ☐

☐ RTA

☐ TTA

☐ Self fall from height

☐ Self fall from floor level

Comorbidities (Tick all applicable)

Diabete☐

HT ☐

TB ☐

(a) Whether treatment completed
(b) Defaulter

Personal Habits

☐ Smoking
If yes (years)

☐ Alcohol

Bronchial Asthma ☐

Malignancy ☐
If yes provide details

☐ thers (Specify) _____

Other associated injuries _____

Previous h/o osteoporosis/ insufficiency fractures _____

Time from injury to admission

X-Ray CT

Neer's classification _____

Final Diagnosis _____

Intra Operative

Time between hospital admission and surgery

Position :

Anaesthesia :

Incision : Approach :

Cephalic Vein: lateralized ☐
Medialised ☐

Greater tuberosity with soft tissue attachment preserved Yes/No ☐

Lesser tuberosity with soft tissue attachment preserved Yes/No ☐

Head size :

Version :

Comments :

Cementation : ☐ Yes ☐ No

Cementation complications ☐ Yes No ☐

Type of cementation _____

Type of reconstruction _____

Anaesthetic complication (if any)

Blood loss Operating Time

Intra operative range of movements tested Yes ☐ No ☐

Shoulder immobilizer applied Yes ☐ No ☐

Post OP

Shoulder immobilizer applied: Yes ☐ No ☐

No. of days _____

Wound status

Drain removal after _____ days Drain Amount _____

Suture removal after _____ days

IV antibiotics _____x_____ days, Pus C/s (if any) _____

_____

Oral antibiotics _____ x _____ days

_____

Associated fractures fixed Yes ☐ No ☐

Details _____

Associated injuries treated Yes ☐ No ☐

Details _____

Discharge Status

Follow Up

Date : No. of Follow up visit :

Month :

Wound Status :

X-Ray : Comments :

UCLA Score :

Constant Shoulder Score:

Neurological Status:

Distal Vascularity: